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MEMOIRS
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GEOLOGICAL SURVEY OF INDIA.

Palæontologia Indica,

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL.

TERTIARY AND UPPER CRETACEOUS FOSSILS OF WESTERN SIND.
Ser. XIV.

Vol. I. 3. THE FOSSIL ECHINOIDEA.
Fasciculus I. THE FOSSIL ECHINOIDEA FROM THE STRATA BENEATH THE TRAP (CARDITA BEAUMONTI BEDS).

WITH 4 PLATES.

BY

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A DESCRIPTION

OF THE

FOSSIL ECHINOIDEA

OF

WESTERN SIND.

I. *Introductory Remarks on previous Works relating to the Fossil Echinoidea of Sind.*

THE museum of the Geological Society of London contains two collections of fossil Echinoidea from Sind; and in one of them there are numerous species from Cutch.

One collection was made and described by Captain Grant.

The other collection was described by MM. d'Archiac and Jules Haime in their great work entitled 'Description des Animaux Fossiles du groupe Nummulitique de l'Inde.' It was beautifully illustrated in that work. The value of the monograph, to labourers in the same field of research, is immense; but, unfortunately, the localities whence the fossils were derived and their correct geological position were not known to the illustrious authors. Moreover their labours were rendered all the more arduous by the unsatisfactory condition of most of their specimens. When such rarities as fossils from India came before geologists, some years ago, species and genera were attempted to be distinguished by the study of specimens on which no trouble would have been spent, had they been derived from well-known European strata. The result has been, that many of the species described by MM. d'Archiac and Jules Haime cannot be accepted now; and, moreover, when their types are compared with their delineations, a considerable amount of imagination must be conceded to have influenced their artist.

The specimens described by MM. d'Archiac and Jules Haime had been collected, without regard to stratigraphy, by Captain Vicary and Mr. Blagrove and others; and whilst some fossils came from somewhere out of the vast depth of Nummulite-bearing rocks in Western Sind, others were derived from later tertiaries. None came from the lowest series of rocks, the fossil Echinoidea of which form the subject of this Part; but some were derived from the higher series, and will be noticed in the description of their fossils.

II. *Origin of the Collections about to be described.*

After the completion of the description of the Fossil Corals of Western Sind [*], the Superintendent of the Geological Survey, H. B. **Medlicott**, Esq., F.R.S., decided to accede to our request and to send to us for description the magnificent series of Echinoidea which had been carefully collected by skilled collectors under the instruction of Messrs. W. T. **Blanford**, F.R.S., the Deputy Superintendent, and Mr. **Fedden**, F.G.S.

The specimens we found to be numerous, usually in a good state of preservation, and to have had their geographical and stratigraphical positions carefully recorded. They had been obtained from all the fossiliferous horizons which had yielded fossil corals to the Survey; and, moreover, there was a collection included from the tertiaries of Cutch.

Anticipating that the examination of the Echinoidea might enable the geological age of the upper members of the great tertiary series to be satisfactorily determined, after the more or less definite statements which the study of the corals had necessitated, we asked for and received a collection of fossils from the Makrán series of Baluchistan and the Persian Gulf. Lately a small collection of recent Echinoidea from the coasts of Sind has been sent.

After considering the work before us, we agreed, with the sanction of the Superintendent of the Geological Survey of India, to bring out the descriptions in Parts, each of which will relate to the fossils of one of the great geological divisions. Every fossil has passed a careful examination by both of us; we have generally drawn the details of the structures; and many difficulties have been surmounted by a process of careful mutual criticism. We have, where it has been possible, considered the varieties of species and the variations during growth.

III. *The Stratigraphical Relations of the Deposits containing Echinoidea in Western Sind.*

The detailed description of the geology of Western Sind is to be found in the Memoirs of the Geological Survey of India, vol. xvii. part 1 (1879), by W. T. **Blanford**, F.R.S. &c., Deputy Superintendent of the Geological Survey of India; and it is therefore only necessary to explain those parts of it which relate to the general succession of the stratigraphical series and the position of the strata yielding Echinoidea.

The mountain-ranges west of the Indus run nearly north and south, in irregular parallel series. The longest range, the Khirthar, is slightly curved, the concavity being to the east; and it extends from slightly south of 26° N. lat. to close to 28° N. lat. The Laki range, more to the east, is nearly coincident with the sixty-eighth parallel of east longitude, and extends from the Indus north of 26° N. lat. to nearly a degree to the south. Other minor but nearly north-and-south ranges occur; and the whole were comprised by MM. d'Archiac and Haime under the title of the Hala range (a name unknown to the natives).

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[*] "A Monograph on the Fossil Corals and Alcyonaria of Sind," by P. **Martin Duncan**, Palæontologia Indica, ser. xiv. vol. i. pt. 2 (1880).

The following is the list of geological formations in Western Sind, and which are to be recognized in one or other of the mountain-ranges *:—

Group.	Subdivisions.	Approximate Thickness.	Age.	Remarks.
		feet.		
ALLUVIAL	....	?	Post-Tertiary.	
MANCHHAR	Upper	5000	Pliocene.	Unfossiliferous.
	Lower	3000–5000	Old Pliocene or Upper Miocene.	Vertebrate remains.
GÁJ	....	1000–1500	Miocene	Coralliferous; no Nummulites.
NARI	Upper	4000–6000	Oligocene.	Unfossiliferous.
	Lower	100–1500		Coralliferous, with *Nummulites garansensis*.
KHIRTHAR	Upper	500–3000	Nummulitic	Nummulitic limestone.
	Lower	6000?	....	Unfossiliferous.
RANIKOT	....	2000	Lower Nummulitic	Fossiliferous. Corals and Nummulites.
TRAP	....	40–90	Deccan Trap.	
CRETACEOUS	*Cardita Beaumonti* beds.	350–450	Transition beds	Fossiliferous.
	Sandstones	700	Cretaceous	Horizon not determined.
	Limestones with Hippurites.	320.		

Explanatory Sections.—In the Laki range, south-west of Amri on the Indus, are dark-coloured hills, which contrast with the cliffs of grey and white Nummulitic limestone behind them. A section close to the hill called Barrah, is given by W. T. Blanford, F.R.S.; and it shows that the range consists of three parallel ridges (see fig. 1, p. 6).

The outer, to the east, is composed of Tertiary rocks; while the intermediate one consists of Cretaceous beds, faulted to the eastward against the Lower Eocene strata, and dipping under them to the westward.

This section shows the normal sequence of the groups of strata from the Cretaceous to the Khirthar inclusive. Above the Nummulitic limestone of this last group, the Nari and Gáj series are wanting, and the Manchhar succeeds †.

On the Gáj river, in the Khirthar range, W. T. Blanford remarks that a thickness of at least 25,000 feet of strata is exposed (see fig. 2, p. 6). The succession from west to east is:—unfossiliferous strata, probably of Cretaceous age, followed by Khirthar strata (the Ranikot series, the lowest Eocene, being absent); then the lower and upper Nari series come in, and are followed by the Gáj and the Manchhar deposits.

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* From the Memoir by Blanford, p. 32, slightly modified.

† Memoirs Geol. Survey of India, vol. xvii. pt. 1, p. 131.

The lowest deposits containing Echinoidea occur in the soft olive shales and sandstones with volcanic ash, belonging to the *Cardita Beaumonti* series below the trap. The accompanying remains are those of Amphicœlian Crocodilia and Corals, *Caryophyllia compressa*, *C. Indica*, *Trochocyathus Lakii*, *Smilotrochus Jakhmari*, *S. Blanfordi*, a *Stylophora*, *Rhabdophyllia Barkii*, and *Litharæa epithecata*. The deposit was neither a reef-structure nor a deep-water one.

The lower part of the Ranikot series, resting immediately on the trap, consists of soft sandstones, shales, clays with gypsum and lignite, and pyritous shale. A few fragments of bones and some dicotyledonous leaves occur. These freshwater strata are succeeded by highly fossiliferous marine limestones, often brown in colour, interstratified with sandstones, shales, clays, and ferruginous bands.

Nummulites appear for the first time; and there is a grand development of Corals, Echinodermata, Gasteropoda, and Cephalopoda. It was not a very deep-water formation. Erosion of the surface of the Ranikot strata occurred before the deposition of the next series.

The Khirthar series includes in its highest portion, a massive, pale or dark grey, hard, compact Nummulitic limestone whose extreme thickness is 3000 feet. It thins out to the south-west, and disappears within a distance of twenty-five miles of its greatest development. Other Nummulitic limestone-beds are found, which may be lower in the series; and they and the main group are represented elsewhere by shaly limestones and sandstones with calcareous bands. In some districts flint occurs in a limestone with *Alveolinæ*. The lower members of the series are often wanting, and are well represented by shales, marls, and sandstones; and where these are present unconformity with the underlying Ranikot beds is not seen; but where they are absent the Nummulitic limestone (as in the Laki range) rests unconformably. The compact limestone is of course highly fossiliferous; but it has not yielded very good specimens of Corals. The indications of a fringing-reef-building fauna, or a bank of coral, are distinct; but the species when compared with their modern analogues do not indicate a great reef-development. Amongst other fossils, Lamellibranchiata prevail, and the Echinoidea are numerous; but the Nummulites and Orbitolites, *Alveolinæ*, and *Patellinæ* are the most important organic remains. Amongst the Nummulites there are *N. Ramondi*, *N. biaritzensis*, *N. Beaumonti*, *N. granulosus*, and *N. Leymeriei*.

The Nari series rests conformably on the Khirthars; and there is occasionally an apparent passage from the Khirthar limestone into a yellow or brown rock of the Nari group. There is, however, a biological break; for the Nummulites of the upper group are characteristic, and differ from those of the lower. The Khirthar forms are not found, and *Nummulites garansensis* appears with *Orbitoides papyracea*, in the Nari series. The rock is a limestone with intercalations of sandstones and shales. As a rule, shales, fine sandstones, and occasional bands of limestone form the base of the Nari group, and pass upwards into coarse, massive, thick-bedded sandstones, attaining a thickness of from 4000 to 5000 feet on the eastern flank on the Khirthar range.

A local break occurs to the south, and the Upper Nari beds rest unconformably on the denuded edges of the Lower Nari brown limestones; and still further south, fifty miles east of Karáchi, there is a well-marked distinction between the upper members of the group with *Orbitoides papyracea* and the lower with *Nummulites garansensis*; and in one locality the upper member overlaps the lower, and rests on Khirthar limestone.

To the east of the Laki range the Nari beds are wanting, and the Manchhar series rests unconformably on the Khirthar, with some pebble-beds of the Gáj series intervening. But to the west of the range the Nari and the Gáj series are found in their normal sequence; and towards the coast the exact distinction which can be drawn elsewhere, stratigraphically and petrologically, between the Tertiary series is not possible: this is mainly due to the disappearance of the limestone element of the Khirthar and Nari series, and to the prevalence of sandstones and shales. The fossils, however, distinguish the groups; but the horizons of the zones of Nummulites and Orbitoides vary, being higher or lower in their proper series according to locality.

The upper sandstones of the Nari group have not yielded marine fossils, and in Upper Sind they contain the remains of plants.

The Nummulites become fewer in their species at the base of the Nari group, and cease to be found in the lower beds of the succeeding series, the Gáj.

The Gáj group, with a base of highly fossiliferous limestones and calcareous beds, more or less shaly and stratified, overlies the softer shales and sandstones of the Nari series. The development of the calcareous series is great; but it is subordinate to an arenaceous element. The sandstones are intercalated with clays with gypsum; and shales and bands of limestone, highly coralliferous, are very constant.

The Gáj series rests conformably on the Nari series; although there is a mineralogical break, the passage is so gradual that calcareous bands of the Gáj series are found interstratified with the uppermost Nari sandstone. The Gáj series overlaps the Nari to the south and rests on the Khirthars, and is wanting in Lower Sind to the eastward of the Laki range.

North-east of Karáchi the series is highly developed, and massive limestones occur; they reach as far as the coast.

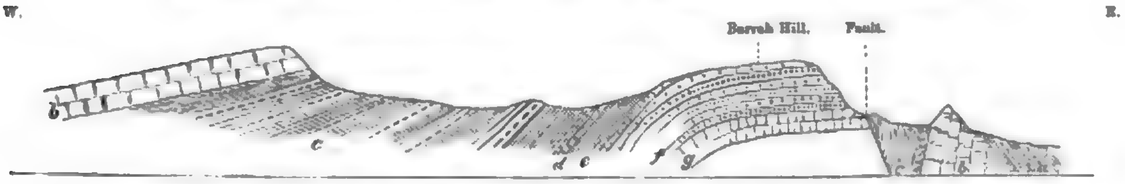
The uppermost beds of the Gáj series are variegated clays and grey sandstones, which form a passage into the overlying Manchhar strata, and contain species of *Ostrea*, *Corbula*, *Arca*, *Scalaria*, *Buccinum*, and *Turritella*. A crab of the genus *Typilobus* and *Vicarya Verneuilii* have also been found there. The oyster is like *Ostrea multicostata*. The Echinoderms are numerous. The Corals found, principally associated with the limestone-beds, are very different in their aspect from those of the underlying Nari group. They belong for the most part to reef-building genera; and some are represented in modern reefs by allied species, which grow in the surf and in the most exposed parts. The rest were dwellers in quiet water. Great masses of the coral limestone consist of *Stephanocœnia maxima* in casts; and the presence of the genera *Madrepora*, *Haliastræa*, and *Porites* is very significant of shallow-water conditions.

Resting on the Gáj strata is the Manchhar group; and where the Gáj beds are wanting, and even where the Nari series is deficient, this upper group rests on the Khirthars. It is not a marine deposit.

The general conformity of this great tertiary series is evident—although local unconformities occur, and there is evidence in favour of there having been some disturbance of the older rocks before the deposition of the Lower Manchhar group. The subsidence which took place during the deposition of these thick shallow-water deposits was vast; and there were occasional slight upheavals. The final epoch of the mountain-formation occurred after the deposition of the Manchhars. The strike of the chains is in the main north-and-south; and the thrust came from the west to the east, and from east to west.

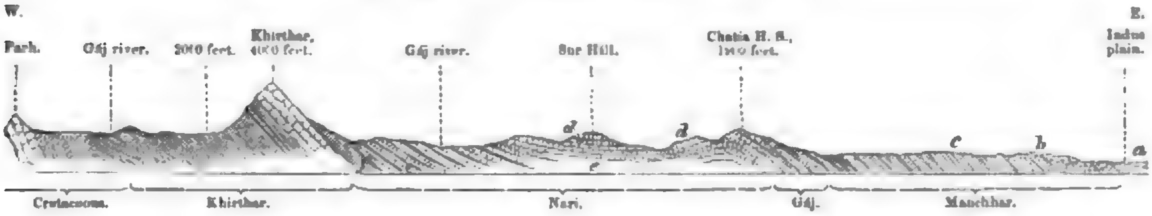
The date of the great mountain-formation is subsequent to the deposition of the sedimentary strata forming the Upper Manchhars.

Fig. 1.—*Section through Barrah Hill.* (Scale, 1 inch to 2500 feet.)



a, Manchhar strata, rest on pale clays of Khirthar age, with *Nummulites Leymeriei*, and then on Khirthar Nummulitic limestone, *b*, the beds dipping to the west. This limestone forms the eastern ridge. West of the ridge is some low ground, in which the upper members of the Ranikot group, *c*, crop out, also with a reversed dip. They end abruptly against a cliff of white and grey limestone, the boundary being a fault. This limestone, *g*, forms the base of the Barrah Hills, and contains Hippurites. A great thickness of sandstones, *f*, forms the top of the dark-coloured hills. On the top of the hills is a bed containing oysters and fragments of apparently reptilian bones. West of the hills are olive shales with *Cardita Beaumonti*, *e*. The trap, *d*, follows, and then the Ranikot group, *c*, which is of great thickness, and the Khirthar limestone, *b*.

Fig. 2.—*General diagrammatic Section of Khirthar Range, on the north bank of the Gáj River.* (After Blanford, half size.)



a, Indus plain; *b*, upper, *c*, lower Manchhars; *d*, Gáj; *e*, upper, and *f*, lower Nari. (Abbreviated from the original.)

IV. *Description of the Fossil Echinoidea from the Strata below the Trap in Sind.*

THE TRANSITION CRETACEOUS SERIES.

List of Species described.

From the strata below the Trap containing *Litharæa epithecata* and *Cardita Beaumonti*.

Order **ECHINOIDEA ENDOCYCLICA.**

Family CIDARIDÆ.

Genus CIDARIS, *Klein*, 1734.

Cidaris lacrymula, *Duncan & Sladen*.

Order **ECHINOIDEA EXOCYCLICA.**

Suborder ATELOSTOMATA.

Family CASSIDULIDÆ.

Genus novum PLESIOLAMPAS.

Plesiolampas elongata, *Duncan & Sladen*.

Genus ECHINANTHUS, *Breynius*, 1732.

Echinanthus pumilus, *Duncan & Sladen*.

Family SPATANGIDÆ.

Genus LINTHIA, *Merian*, 1853.

Linthia Sindensis, *Duncan & Sladen*.

The fossil Echinoidea collected by the Geological Survey of India from the beds beneath the Trap and underlying the Nummulitic series were obtained from below Jakhmari peak in the Laki range west of Amri and from Barki nala north of Ranikot, also in the Laki range.

None of the Echinoidea described by MM. d'Archiac and Jules Haime were found in these strata below the Trap.

Order ECHINOIDEA ENDOCYCLICA.

Family CIDARIDÆ.

Genus CIDARIS, *Klein*, 1734.

Test circular, more or less depressed above and below.

Ambulacral areas narrow, flexuous. Poriferous zones composed of simple pairs of pores, non-conjugate, the dissepiment usually developing a more or less prominent granuliform swelling. Interporiferous spaces narrow, bearing granules only.

Interambulacral areas wide, usually three or four times the width of the ambulacral areas, with two vertical rows of primary tubercles. Primary tubercles large, perforate or imperforate, crenulate or non-crenulate, rising from a circular or oval scrobicule, surrounded by a scrobicular ring of miliaries.

Apical system large, subcircular.

Peristome subcircular, without notches.

Spines elongate, robust, very variable in form and ornamentation.

1. Cidaris lacrymula, sp. nov. Plate I, Figs. 1–7.

Form circular, depressed, tumid at the ambitus, and smaller above than below, where there is considerable flattening. Height of the test about one half of the diameter.

Ambulacra rather broad and slightly flexuous. Poriferous zones broader than half the interporiferous area, and slightly sunken. The pores are large and transversely elliptical, non-conjugate, being separated by a vertical and convex process, which externally resembles a compressed granule; this merges aborally and adorally into the general superficies of the plate, which is continued around the pores in more or less of a ridge. There are 26 to 27 pairs of pores in relation to two of the largest interambulacral plates. The interporiferous (ambulacral) areas are narrow, and have at the ambitus two rows of small mamillated tubercles placed close to the pores, and two rows of very small tubercles (miliaries) between them. Near the apex and actinostome these central small tubercles are not seen.

The interambulacral areas are about three times the width of the ambulacra at the ambitus; and there are two rows, of six to seven primary tubercles, in each interambulacrum.

Primary tubercles moderately prominent; mamelons rather small and somewhat depressed, not crenulated. Scrobicules wide, circular, occupying much of the plate, and only slightly sunken; the tubercle not greatly elevated, surrounded by a complete circlet of small mamillated tubercles, the boss being somewhat shield-shaped, with the truncate margin falling into the scrobicular circle, and the mamelon more or less tear-shaped, the tapering extremity being directed inwards towards the primary tubercle. There are about thirteen of these secondary tubercles in the ring; and between each of them alternates a small simple tear-shaped miliary tubercle, with the fine extremity pointed inwards. The miliary zone is narrow, naked along the suture, and slightly impressed, the ornamentation consisting of one or two series of small tear-shaped granules which are placed external to, and alternate with, those of the scrobicular ring above mentioned. On the aboral and adoral margins of the interambulacral plates, however, there is only room for the accommodation of the granules of the scrobicular ring; and as the plates approach the actinostome the adoral margin even of this is more and more encroached upon. On the side, between the ring and the poriferous zone, there is seldom more than a single series of the small miliary granules supplementary to those of the ring.

Peristome rather small, margins more or less inturned. Apical disk comparatively large. The preservation of the specimens unfortunately renders any further details unobtainable. Radioles unknown.

Dimensions. Height of the larger specimen $\frac{6}{10}$ inch. Height of the smaller specimen $\frac{4}{10}$ inch. Width $\frac{8}{10}$ inch.

Locality. Below Jakhmari peak, Laki range, west of Amri. Survey-number G $\frac{280}{137}$.

Remarks. There are two specimens of this *Cidaris*, one small and without its apical system, and the other more fully grown but more or less crushed. They belong to the same species.

Illustrations of the Species in Plate I.

Fig. 1. The test, seen in profile: natural size.
2. The same: magnified.
3. A portion of the ambulacral area: magnified.
4. Profile outline of the same.
5. Interambulacral plate: magnified.
6. A primary tubercle, seen in profile: magnified.
7. A portion of the scrobicular ring, showing the shield-shaped boss of the tubercle and the tear-shaped mamelon: magnified.

Order **ECHINOIDEA EXOCYCLICA.**

Suborder ATELOSTOMATA.

Family CASSIDULIDÆ.

Genus PLESIOLAMPAS, gen. nov.

Test oval, elongate, depressed, gently convex above, concave beneath around the peristome; actinal surface and margins tumid.

Ambulacra subpetaloid, unequal, widely open at the extremities. Poriferous zones almost straight, subequal. Pores round, subequal, the outer slightly elongate.

Apical system compact, excentric in front.

Peristome subcentral or slightly excentric in front, subpentagonal.

Poriferous zones continued on the actinal surface in single pores; a few supplementary ones present near the peristome; floscelle rudimentary.

Periproct larger than peristome, inframarginal, oval, placed longitudinally.

Tubercles numerous, small, non-mamillated, imperforate, non-crenulate, completely sunken in deep, wide scrobicules; miliary granulation compact.

The genus to which the present form is most nearly related, is *Echinolampas*, of which, indeed, the fossil might at first sight almost be regarded as an abnormal species.

On examination, however, it is found to differ from *Echinolampas* in so many points that we feel compelled to regard it as the type of a new genus.

Plesiolampas differs from *Echinolampas* in its almost straight ambulacra, its subequal poriferous zones, its round, nearly equal pores, its periproct placed longitudinally, its mouth, and the absence of a definite floscelle, and, lastly, its imperforate tubercles.

The large longitudinal periproct of *Plesiolampas* recalls *Amblypygus*, from which, however, the present genus is easily distinguished by the form of the test, the characters of the ambulacra (above mentioned), the single pores on the ambulacral plates of the actinal surface, and the character of the peristome, which in the new form is subpentagonal or transversely elongate and certainly not oblique.

No other Cassidulid appears to approach sufficiently near to need comparison.

This genus is also represented in the Ranikot series above the Trap in Sind.

1. PLESIOLAMPAS ELONGATA, sp. nov. Plate I, Figs. 8–16.

General form elongate, depressed, convex above, tumid at the sides and in front, slightly rostrated behind. Actinal surface sunken round the peristome, otherwise convex. Marginal contour nearly elliptical, rather more rapidly tapering behind than in front, and also slightly truncate. The longitudinal profile shows the apical summit to be slightly excentric in front, and more so than the peristome; the posterior slope is very gradual until it reaches the margin, where it is roundly curved over the posterior rostration; the anterior slope is much more rapid, and the rounding of the upper portion of the margin less bombous. The transverse profile shows the dorsal area to be evenly rounded, not conoid; and the lateral slopes are more rapid than either of the slopes of the longitudinal profile.

The apical system corresponds with the apical summit of the test, the distance from the centre of the system to the anterior margin being about 40 per cent. of the length.

There are four generative pores, which are large; the anterior pair round, and the posterior pair elongate and subpyriform and larger than the anterior pores. The ocular plates and pores are exceedingly small. The madreporiform body occupies the whole of the centre of the system.

The ambulacra are narrow, straight, flush with the surface of the test, widely open, and do not reach the margin, the posterior pair being the most remote from it. The postero-lateral ambulacra are rather longer than the antero-laterals; but these latter are perhaps slightly broader, and the odd anterior ambulacrum is a shade narrower than either of the others. The anterior pair form an angle of 135° with one another, and the posterior pair an angle of 61°, this latter being the index of the odd posterior interradium. The shape of the odd anterior ambulacrum and of the posterior pair is that of a straight narrow band, converging regularly and somewhat rapidly to the small extremity at the apical pole; and their breadth, at the widely open extremity, is only the slighest degree narrower than the breadth at the widest portion across the middle of the petal. In the anterior lateral petals the posterior zone is slightly curved outward, whilst the anterior one is straight.

The poriferous zones are narrow and of uniform breadth throughout, excepting the normal diminution of size at the extremity as they approach the apical pole. The breadth of the poriferous zone is rather more than half the breadth of the interporiferous area. The pores are almost equal, the inner pores of a zone being round, the outer ones very slightly elongated transversely—so slightly, however, that it is scarcely perceptible. The pores are very faintly conjugate; for the furrow between them is most faint, and is produced merely by the bevelling of the narrow dissepiment. This dissepiment is of uniform breadth throughout the zone. In the postero-lateral ambulacra the anterior zone has 43 pairs of pores, and the posterior zone has only one pair less; in the antero-laterals the anterior zone has 35 or 36 pairs of pores, and the posterior zone one pair less. The odd anterior ambulacrum has probably nearly the same number of pores; but it is impossible to state this definitely, owing to the outer portion of the petal being concealed. The series of double pores (or, in other words, the petals) terminate abruptly at about one third of the distance from the margin to the apex. A series of only single microscopic pores is carried forward over the ambitus; and there is scarcely any increase in size, until half of the actinal portion of the ambulacrum has been traversed; they then increase in size and proceed to the peristome, there being still a single pore to a plate. At the oral extremity of the ambulacrum there are traces of two or three supplementary pores, which are probably the indications of an incipient or rudimentary phyllode. Unfortunately the preservation of this portion of the test is not such as to allow of definite determination. The ornamentation of the interporiferous area within the petal is similar to that of the interambulacral plates, and consists of rather widely spaced, small primary tubercles, non-crenulate, sunken in a wide and deep scrobicule, the interspaces being filled with a miliary granulation, and which has become confluent to a great extent, owing to dense crowding. The scrobicules are as wide as, or wider than, the ambulacral plates; and they do not occur upon every plate in the series, but are usually separated by one or two blank plates, the arrangement of the tubercles being quite irregular.

In the interradial areas on the abactinal portion of the test the plates are comparatively broad, and have a sharp angular bend. The plates are uniformly covered with primary tubercles and intermediate granulation similar to that already mentioned, excepting that perhaps the scrobicules and their contained tubercles are slightly larger. The tubercles are rather wide apart; but at no place is the intermediate granulation equal in breadth to the diameter of the scrobicule. About four irregular alternating horizontal lines of primaries may be traced on a plate. The interradial plates are equal in length (depth) to six or seven of the ambulacral plates at the middle of a petal. On the actinal surface of the test the scrobicules are somewhat larger than those in the abactinal area; they are also more closely placed, and the intermediate granulate portion is much narrower, frequently not more than the breadth of a single series of granules.

The peristome is slightly excentric in front, small, and deeply sunken. It appears to be subpentagonal in shape; but, owing to the condition of the specimen, it is impossible to determine with accuracy the details of the form and structure of this and the adjacent parts of the test. There appears to have been no development of the peristomial interambulacral plates (bourrelets), although it is probable that a rudimentary floscelle was formed by the small incipient phyllodes above referred to.

The periproct is large, elongate, oval or subpyriform, the long axis placed longitudinally, half on the margin and half on the actinal surface of the test, quite invisible from above, and overarched by the slight posterior rostration of the odd posterior interradium. It measures about one quarter of an inch in length, and is much larger than the mouth. Too great importance, however, must not be placed upon the actual measurement, as the margin of the aperture has been to a certain degree modified by damage, either previous to fossilization, or during the process of clearing from the matrix when found.

Dimensions. Length of the specimen $1\frac{9}{10}$ inch; breadth $1\frac{1}{10}$ inch; height $\frac{1}{2}$ inch.

Distance of apical system from posterior edge $\frac{9}{10}$ inch.

Locality. Below Jakhmari peak, Laki range, west of Amri. Survey-number G $\frac{280}{137}$.

Illustrations of the Species in Plate I.

Fig. 8. Abactinal aspect of the test: natural size.
9. Actinal aspect of the test: natural size.
10. Outline of the longitudinal profile of the test.
11. Outline of the transverse profile of the test.
12. Apical system: magnified.
13. A portion of the ambulacral and interambulacral areas: magnified.
14. Part of an ambulacrum near the peristome: magnified.
15. Tubercles on the abactinal surface: magnified.
16. Tubercles near the ambitus: magnified.

Genus ECHINANTHUS, *Breynius*, 1732.

Test oval, elongate, subdepressed, more or less convex above, and slightly concave below; margins tumid.

Ambulacra petaloid; petals short, unequal, widely open at their extremity. Poriferous zones subequal, with pores round or oblong; pairs conjugate, united by a groove.

Apical disk compact, excentric in front.

Peristome subpentagonal, more or less excentric in front; floscelle more or less developed.

Periproct oval, often vertically elongate, marginal or supramarginal, placed at the summit of a more or less well-developed groove.

Tubercles small, crowded, perforate, non-crenulate, sunken in a deep scrobicule; miliary granulation more or less compact.

1. **Echinanthus pumilus**, sp. nov. Plates II & III.

General form depressed, longer than broad, convex above; sides high, rounded and tumid; actinal surface slightly concave towards the mouth. Marginal contour rather widely oval, broadest posteriorly, slightly truncate at the posterior extremity, and faintly incised by the shallow infraperiproctal groove. The longitudinal profile shows the apical summit excentric in front, the posterior slope very slight indeed, the anterior one rather more rapid and rounded, and the whole dorsal area comparatively flat, in consequence of the uniformly high, thick margin or sides, equally rounded above and below. The transverse profile a regular curve, of slight elevation, very faintly conoid over the apical summit. Posterior extremity slightly truncate, almost vertical. Periproct elongate, oval, vertical, situated at the extreme top of the extremity, the margins above and laterally being slightly carinate, whilst an extremely faint groove is developed below, which dies out as it passes over the margin onto the actinal surface.

The apical system corresponds with the apical summit of the test, is excentric in front, the distance from the centre of the system to the anterior margin being about 40 per cent. of the length. The generative pores, four in number, are large; the anterior pair closer than the posterior, the large madreporiform body, which occupies the space between, being covered with miliaries. The ocular plates are large, although their pores are very small. The anterior ocular plate fits in between the anterior generative plates, and also the ocular plates of the antero-lateral ambulacra between the anterior and posterior genital plates. The posterior ocular plates do not come so far within the posterior generative pair, and are themselves separated by the intrusion of the madreporic body.

The ambulacra are narrow, rather short, and nearly equal, the posterior being slightly longest. All are subpetaloid and open externally, the posterior pair ending a little nearer the margin than halfway from the apex, the other ambulacra approaching the ambitus more closely. The anterior ambulacrum is a shade narrower than the others; and the poriferous zones do not approximate as they approach the ambitus, so as to form a petaloid interporiferous area, the breadth of which in this ambulacrum is as great at the distal extremity as at the middle of the petal. The anterior pair of ambulacra form an angle of 136° with one another, and the posterior pair an angle of 57°, this latter being the index of the odd posterior interambulacrum.

The poriferous zones are narrow and of uniform breadth throughout, excepting the normal diminution of size at the extremity on approaching the apex. The zones are slightly sunken, and the interporiferous areas slightly raised or flush with the test; and the zones of the odd anterior ambulacrum are a little irregular in their direction. The breadth of the poriferous zone is rather less than one half of the breadth of the interporiferous area. The pores are equal, round, and conjugate, the grooves being oblique and very distinct; the keel between with a row of granules. There are about 26 to 28 pairs of pores in each zone of the anterior and antero-lateral ambulacra, and 32 in the posterior. A single pore only of each zone is continued from the termination of the petals and passes over the ambitus, *i. e.* one pore to a plate, situated in a little elongate, oblique groove,—the interporiferous area (or, more correctly here, the ambulacral area) expanding from the petal up to the ambitus, and from thence contracting until near the phyllode, when it again expands. The phyllode is well developed, widening moderately and then contracting with a graceful curve as it approaches the margin of the peristome. The plates are short and broad, and the pores consequently closely placed. The pores are rather large, sunken in little cavities, punctured between the sutures of two neighbouring plates, all uniformly distant from the outer extremities of the plates. A double series of inner, supplemental pores, 7 to 10 in number, are present within the phyllode, each pore borne on the margin of a small supplementary plate inserted between the regular series of ambulacral plates which constitute the phyllode. These supplementary plates are not more than half the breadth of the primary ones, excepting the outermost of the series, which usually extends the whole breadth of the ambulacral column. Two, or even three, primary plates stand between each secondary or supplementary; consequently the inner pores are much wider apart than the outer series. The inner pores are placed in two straight lines, which diverge slightly, being closer together adorally than aborally. The punctures of the peristomial ambulacral plates are large and placed close together within the actual margin of the peristome; they are separated only by a broad dissepiment; and a narrow bridge-like strip forms a sharp although diminutive ridge arching over them above and dividing them from the inner pores of the phyllode just described. Immediately above, *i. e.* aboral to, this ridge are several blind pits, not punctured, which are probably the cavities in which sphæridia were placed, and which, on cursory examination, are at first sight rather liable to be confused with the inner pores of the phyllode. The ornamentation of the interporiferous area, within the petal, is precisely similar to that of the interambulacral area, and consists of minute primary tubercles, perforate and crenulate (the latter quite microscopic), situated within a deep and moderately wide scrobicule. The margin of the scrobicule is composed of small, closely placed, uniform miliaries, forming a complete circle which comes close up to those of the neighbouring primaries, any interspaces being filled up with miliaries. The whole miliary granulation is compact and confluent, forming a uniform test-surface level with the tops of the primary tubercles. Near the ambitus the tubercles are slightly smaller and more crowded, the miliary interspaces being much reduced, and consisting only of single lines of miliaries, which are also more completely coalesced. Towards the actinostome the primary tubercles are more widely separate; but on the rest of the test the ornamentation is remarkably uniform and closely crowded.

The peristome is considerably excentric in front, moderately large, elongate transversely, and pentagonal, the amount of angularity varying considerably. The actual margin is very deep, plunging upwards nearly vertically. The interradial peristomial plates form well-developed bourrelets, which are large, broad, more or less bombous, and with a crested rim, the whole peristomial ring being granulated with a minute tuberculation, becoming very much smaller on the ambulacral than on the interradial plates. The periproct is moderately large, oval, with the elongation vertical, placed at the extreme upper portion of the posterior end of the test, the upper extremity of the orifice being just apparent when the test is viewed from above. In some specimens the median interradial portion of the odd interambulacrum is rather bombous and subcarinate in the neighbourhood of the orifice; but this is a character subject to more or less variation, as is also the development of the subanal groove: these modifications will be mentioned below.

Variations. The variations of form, in specimens of the same size, chiefly affect the general shape. Some are more circular, more swollen posteriorly, and broader than others. Indeed there almost appear to be two types of this species, one of greater length than the other in relation to breadth and with a more angularly pentagonal peristome; but intermediate forms unite them in one species. In some examples, again, the interradial areas are more bombous around the peristome, which is less transversely elongate and rather more deeply sunken, the bourrelets being narrower and less prominent, and the phyllodes slightly sunken, which brings out the latter into very distinct definition.

Premature Forms. A large series of specimens was collected, so that it is possible to trace the method of growth and the changes which occurred in the morphology of the test in young and older forms.

Young specimens, $\frac{4}{10}$ inch in length, are of the same breadth, and measure rather more than $\frac{2}{10}$ inch in height. The mouth is very slightly excentric; the periproct large, and not in a groove, but on the rounded margin, close on to the dorsal area, and consequently at a very much higher plane than the mouth. The globular appearance is marked.

Another, rather more than $\frac{5}{10}$ inch in length, is rather less in breadth, and is $\frac{3}{10}$ inch in height; it has the mouth more excentric; the keel on the back has commenced; and the periproct is at its end and high up, there being no groove. The ornamentation is very similar everywhere.

Another, not quite $\frac{6}{10}$ inch broad, is rather over $\frac{6}{10}$ inch in length, and the height is rather over $\frac{3}{10}$ inch. $\frac{7}{10}$, $\frac{6}{10}$, and $\frac{3}{10}$ are the respective measurements of another specimen.

Hence it follows that *Echinanthus pumilus* is more globular when young, and that during the process of growth the test increases more in length than in breadth, and that there is a still greater proportional diminution in height. In addition to the greater breadth of the young forms when compared with the older, the test is relatively higher behind, and the apical system is slightly more excentric than the peristome. The character of the ambulacra appears to undergo little change, even the wavy irregularity of the zones of the odd anterior petal being present in the early stages. The conjugation of the pores, however, is not apparent in very young phases.

Remarks. Fractured specimens show a thin test, and that there is not the slightest arrangement of internal pillars or doubling of the walls. The character of the present species recalls strikingly that of small specimens of the *Echinanthus scutella* of European geologists; and the conformity of the structure of the mouth of the Sind form to that of known Cassidulidæ is absolute, and is altogether distinct from that of the so-called *Echinanthi* of A. Agassiz, which are true Clypeastroids.

The present species is well characterized, and readily distinguishable from other known forms. *E. testudinarius*, Desor, and *E. Biarritzensis*, Cotteau, are, perhaps, the nearest related. Compared with *E. testudinarius*, the keeled and elevated posterior interambulacrum, the greater height posteriorly of the test, the greater length and the smaller angle of divergence of the posterior petals, as well as the general shape of the ambulacra and the different character of the posterior extremity in the new form are distinctive. From *E. Biarritzensis* the Sindian species is well marked by its more broadly oval contour, with no trace of rostration posteriorly, by its greater depression, by its much narrower and smaller ambulacral petals, and by its elongately ovate periproct.

The nature of the posterior truncation, the absence of a projection posteriorly beneath the periproct, and, more important still, the character of the ambulacra and of the peristome separate the species from *Cassidulus* as a genus.

The absence of the longitudinal smooth band between the mouth and the periproct, the outline of the posterior portion of the test, and the vertical position of the periproct distinguish the species from members of the genus *Pygorhynchus*. In some specimens, however, a slight median smooth space occurs along the median line of the posterior interradium; but this is in all probability only the result of wearing, as tubercles are present in well-preserved specimens.

The species above described is not comparable with any form of *Echinolampas*, the position of the periproct, its longitudinal elongation, the simplicity and equality of the ambulacra, and the well-developed floscelle readily remove our form from that genus. Neither is it comparable with the *Rhynchopygus*, *Botriopygus*, *Nucleolites*, or *Echinobrissus* of palæontologists.

Leaving out the details of structure enumerated above, which clearly determine the generic position of this species, the form may be said to recall in a general way some of the characters of *Catopygus* and *Echinolampas*—this, however, suggestively rather than in reality.

Dimensions. The following are the measurements of three of the largest specimens:—

Length $1\frac{1}{20}$ inch, $\frac{9}{10}$ inch, 1 inch.
Breadth $\frac{9}{10}$ inch, $\frac{8}{10}$ inch, $\frac{9}{10}$ inch.
Height $\frac{4}{10}$ inch, $\frac{4}{10}$ inch, $\frac{4}{10}$ inch.

Locality. Barki nala, hills north of Ranikot, Laki range. Survey-number G $\frac{280}{136}$.

Illustrations of the Species in Plates II & III.

Plate II.

Fig. 1. Actinal aspect of the test: natural size.
2. Abactinal aspect of the test: natural size.
3. Profile view of the test, showing the posterior extremity: natural size.
4. Outline of the transverse profile of the test.
5. Apical system: magnified.

Fig. 6. Apical system from another example, considerably weathered: magnified.
7. Peristome and floscelle of the same specimen as Figs. 1–5: magnified.
8. Tuberculation of the abactinal surface: magnified.
9. Tuberculation of the actinal surface, just below the ambitus: magnified.

Plate III.

1. Abactinal aspect of the test of another specimen: natural size.
2. Longitudinal profile of the same: natural size.
3. Transverse profile of the same, showing the posterior extremity: natural size.
4. One of the ambulacral petals: magnified.
5. The two posterior phyllodes of the floscelle: magnified.
6. Longitudinal profile of another specimen: natural size.
7. Transverse profile of the same, showing the posterior extremity: natural size.
8. Actinal aspect of another specimen: natural size.
9. Portion of the margin of the peristome of the same, showing the oral termination of the ambulacra and the formation of the phyllode, denuded of ornament: magnified.
10. Actinal aspect of another specimen: natural size.
11. Portion of the margin of the peristome of the same, seen obliquely, denuded of ornament: magnified.
12. Abactinal aspect of the test of a small specimen, with well-developed keel: natural size.
13. Longitudinal profile of the same: natural size.
14. Transverse profile of the same, showing the posterior extremity: natural size.
15. Abactinal aspect of the test of a small specimen: natural size.
16. Abactinal aspect of the test of a still smaller specimen: natural size.
17. Three odd anterior ambulacra: magnified.

Family SPATANGIDÆ.

Genus LINTHIA, *Merian*, 1853.

Test oval, subcordiform, convex above, flat beneath.

Ambulacra petaloid, sunken, unequal, the posterior pair shorter and less divergent than the anterior pair. Poriferous zones equal; pores subequal. Anterior odd ambulacra different from the others, placed in a deep anterior groove, which may or may not indent the margin. Poriferous zones composed of small pores, in simple pairs, more or less widely spaced.

Apical system compact, excentric in front.

Peristome bilabiate, excentric in front.

Periproct oval, situate at the summit of the posterior extremity.

Peripetalous fasciole complete, more or less indented between the lateral ambulacra. Lateral fasciole branching off from the peripetalous fasciole near the extremity of the antero-lateral petals, and passing below the periproct with a rapid curve.

Tubercles small, prominent; scrobicules very shallow.

1. Linthia Sindensis, sp. nov. Plate IV.

The test is rather depressed; marginal contour roundly heart-shaped, truncate behind, and broadly and rather deeply grooved in front. It is as broad as it is long, the greatest breadth being in a line with the apical system, and the margin being more rounded in front of this line than behind it. The upper surface is more or less uniformly convex, and the posterior interambulacrum slightly carinated. Seen in longitudinal profile, the highest point of the test is situated opposite the middle of the posterior ambulacra, the posterior declivity being sharply truncate behind and sloping at a high angle to the margin, whilst the anterior is gradual and well rounded. The transverse profile is almost semicircular, the posterior keel being slightly prominent. The under surface is rather inflated; the margins tumid, except posteriorly, where the test is rather deeply impressed. It is well rounded in the neighbourhood of the postero-lateral ambulacra.

The apical system is slightly excentric in front. There are four large generative pores; and a small madreporiform body is connected with the right anterior plate. The posterior pair are much wider apart than the anterior pair; and those of each side are very close. This arrangement pushes the ocular plates of the antero-lateral ambulacra to the outside of the generative plates. The anterior ocular plate, however, comes well between the front generative plates, and separates them completely, whilst the madreporiform body, which is rather large, separates the posterior ocular plates. The ocular foramina are very small.

The ambulacra are unequal, rather broad, and moderately sunken. The anterior pair are much longer than the posterior, in the proportion of 2 : 3, and are also more divergent. The odd anterior ambulacrum is feebly developed, wide, and not very deeply sunken until near the margin. The pores are minute and round; the first five or six pairs are very small and are placed in close succession near to the apical system. Further out the plates become broader and the pores wider apart and oblique, and there is a raised partition which separates one pore from another. The antero-lateral ambulacra are long, straight, ovate lanceolate, petaloid, broadest at the outer third, very wide apart, and enclose an angle of about 126°. In length they occupy fully two thirds of the distance between the apical disk and the margin, and are rather deeply sunken.

The poriferous zones are broad where fully developed, the pores being conjugate and elongate, except near the apex, where they are circular; about 27 pairs exist in each poriferous zone, the outer pairs being close to the peripetalous fasciole, but not touching it. The interporiferous area is very narrow, scarcely more than half the breadth of a poriferous zone.

The postero-lateral ambulacra are narrower, and shorter by one third than the anterior pair, and are much less divergent, the angle enclosed being 66°. They are lanceolate or elongately ovate, their distal ends being crossed by the fasciole. 18 or 19 pairs of pores exist in each zone; and the interporiferous area is narrow. The interambulacra are slightly swollen and formed into ridges near the apex and on either side of the anterior groove, the posterior interambulacrum being also elevated into a slight keel.

The ornamentation of the test is slight and inconspicuous, the tubercles being very small. A few rather larger ones are scattered on either side of the anterior groove, and accumulate on the anterior slope of the test. Smaller tubercles are distributed uniformly on the dorsal surface of the test, except near the ambulacra and apex, where they are slightly larger and more crowded. Surrounding the posterior truncation the tubercles become larger and scarcer inferiorly, and above on either side of the periproct; but below the aperture they are almost, if not quite, wanting.

Periproct oval, vertical, and placed high up on the truncated end of the test.

The peristome is small, placed far in front and near the margin, the anterior groove being distinctly continued up to it. The lip is not prominent, the neighbourhood of the mouth is rather impressed, and the plastron is rather swollen—circumstances which, together with the tumid character of the margin, relieve the flatness of the under surface. The ornamentation of the plastron consists of a few large and many small tubercles; and the sides of the test beneath have larger tubercles than the rest of the test. The tubercles below are crenulate and perforate, the slightly sunken scrobicule being surrounded by a sparely filled circle of small miliary granules.

The peripetalous fasciole is very narrow, and forms an angle in the interspace between the lateral ambulacra, reaching up halfway to the apex. The fasciole turns round the anterior lateral petal, passes inwards parallel with it, forming the angle just mentioned, and then crosses over to the posterior lateral petal, coming into contact with its outer pores, and crossing directly over the keel of the posterior interambulacral area to the opposite side. In front the fasciole crosses the anterior odd ambulacrum a little below the line of the end of the antero-lateral petals; but it is very small and indistinct in this portion of its course. A lateral fasciole commences where the peripetalous fasciole begins to pass inwards, a little behind the end of the antero-lateral petal, and extends in a very thin and slightly raised line directed backwards and downwards and passing under the periproct to the other side.

Remarks. Linthia Sindensis is characterized by its general rotundity of margin, its equal length and breadth, its greater breadth in front, its moderate height, and the gentle declivity of the dorsal slope, its deep anterior groove (which is very decided at the margin), and the anteriorly excentric position of the apical system, by the number of close pores in the anterior ambulacrum and the comparative length of the postero- to the antero-lateral ambulacra (as 2 to 3), by the narrowness of the interporiferous zone, and by the very narrow and slightly bent fasciole (which is comparatively faintly angulated, excepting its sharp dip far below the oval periproct).

This Echinoid is, on the whole, rather more closely allied to Cretaceous than to Nummulitic forms. The Sindian species differs from *Periaster pyrenaicus*, Cotteau (its nearest ally), in the shape and proportions of the ambulacra, the greater lateral rotundity of the marginal contour, the greater depth of the anterior groove, the form of the peripetalous fasciole, and the character of the ornamentation of the test. No other form at present known appears to come sufficiently near to require a special comparison to be made.

Dimensions. Length of the test 1 inch; breadth 1 inch; height over ½ inch.

Locality. Below Jakhmari Peak, Laki range, west of Amri. Survey-number G $\frac{280}{137}$.

A large specimen of the same species (larger than the type) from the same locality, but bearing the Survey-number G $\frac{280}{141}$.

Illustrations of the Species in Plate IV.

Fig. 1. Abactinal aspect of the test: natural size.
2. Longitudinal profile of the same: natural size.
3. Transverse profile of the same, showing the posterior extremity: natural size.
4. Outline of the transverse profile of the test: natural size.
5. Apical system: magnified.
6. Apical extremity of the odd anterior ambulacrum: more highly magnified.
7. Portion of the test, showing the passage of the peripetalous fasciole near the extremity of a petal: magnified.
8. Portion of the test, showing the ornamentation near the lateral fasciole: magnified.
9. One of the large tubercles on the actinal surface: magnified.
10. Tubercles of the abactinal surface: magnified.
11. Profile view of the same: magnified.

V. *Remarks on the Fauna of Echinoidea of the Beds beneath the Trap.*

The examination of the Echinoidea of the strata below the Trap, which, very probably, is post-Cretaceous in age, and is certainly older than the age of Nummulites, does not indicate any definite horizon.

The facies of the collection is more Tertiary than Secondary. But this statement must not be made use of in too definite a manner; for in the Ranikot series of the Nummulitic age above the Trap there are Cretaceous types, which give its fauna, in part, an older appearance than that of the *Cardita Beaumonti* beds now under consideration.

There are no characteristic genera in the fauna; and the new genus has species in the Ranikot group also.

In fact, the Echinoidea, like the Corals*, do not define the age of this sub-Trap horizon. The fauna is not Cretaceous in the European sense, nor are its genera and species the same as those of the Cretaceous rocks of Southern India or of Bagh in the Narbada area. On the other hand, the facies of the *Echinanthus* and *Linthia* are rather of a Lower-Eocene character; but there does not appear to be any species common to the Nummulitic series, even of Egypt, and the strata beneath the Trap in Sind.

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* P. Martin Duncan, "Fossil Corals of Sind," Palæontologia Indica, ser. xiv. (1880).

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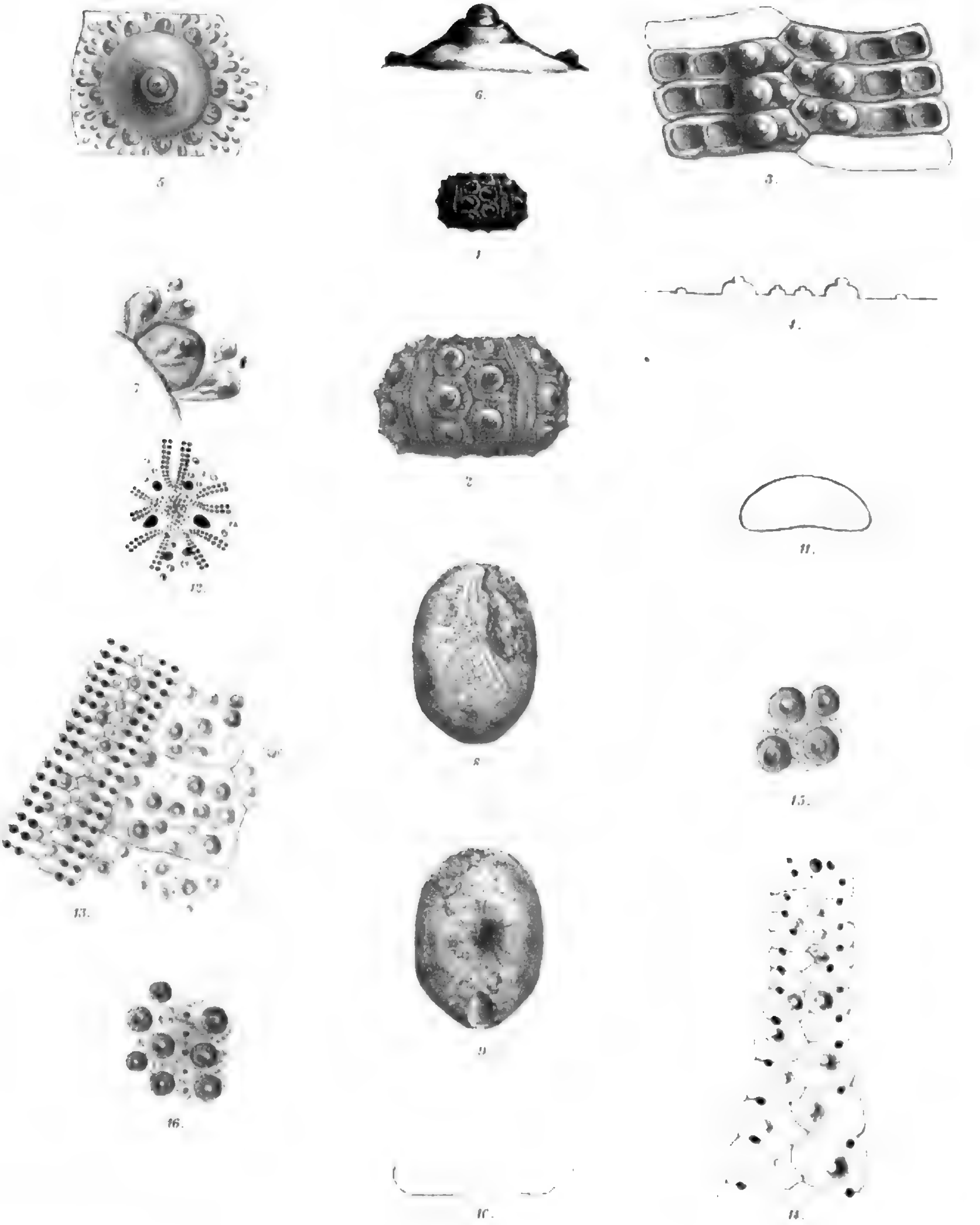
VI. *Description of the Plates.*

PLATE I.

Figure 1. Cidaris lacrymula, Duncan and Sladen (page 8). The test seen in profile, natural size.
2. The same, magnified.
3. A portion of the ambulacral area, magnified.
4. Profile outline of the same.
5. Interambulacral plate, magnified.
6. A primary tubercle seen in profile, magnified.
7. A portion of the scrobicular ring, showing the shield-shaped boss of the tubercle and the tear-shaped mamelon, magnified.
8. Plesiolampas elongata, Duncan and Sladen (page 10). Abactinal aspect of the test, natural size.
9. Actinal aspect of the test, natural size.
10. Outline of the longitudinal profile of the test.
11. Outline of the transverse profile of the test.
12. Apical system, magnified.
13. A portion of the ambulacral and interambulacral areas, magnified.
14. The part of an ambulacrum near the peristome, magnified.
15. Tubercles on the actinal surface, magnified.
16. Tubercles near the ambitus, magnified.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Drawn & [illegible] by A. S. [illegible] lith.

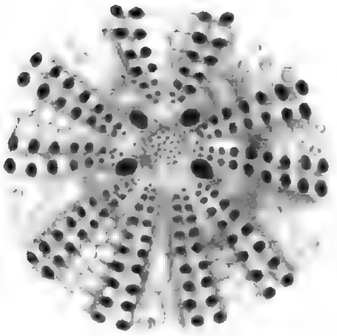
Fossil Echinoidea from Sind.
From below the Trap.

Mintern Bros. imp.

PLATE II.

Figure 1. Echinanthus pumilus, Duncan and Sladen (page 13). Actinal aspect of the test, natural size.

2. Abactinal aspect of the test, natural size.
3. Profile view of the test, showing the posterior extremity, natural size.
4. Outline of the transverse profile of the test.
5. Apical system, magnified.
6. Apical system from another specimen, considerably weathered, magnified.
7. Peristome and floscelle of the same specimen as Figs. 1–5, magnified.
8. Tuberculation of the abactinal surface, magnified.
9. Tuberculation of the actinal surface, just below the ambitus, magnified.



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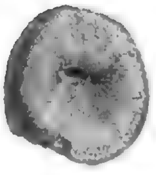

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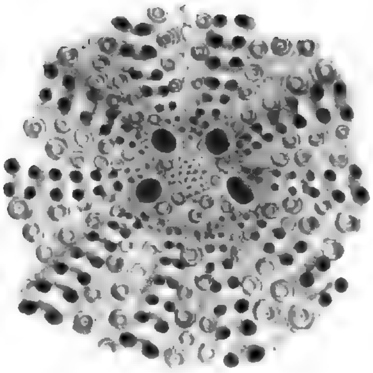

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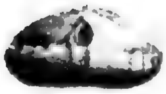

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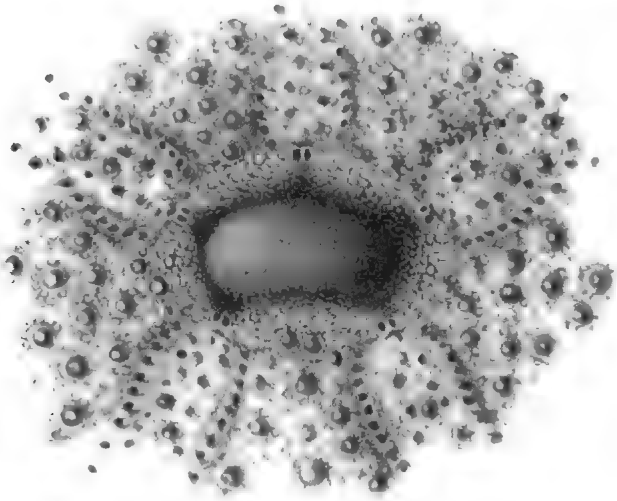

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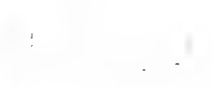

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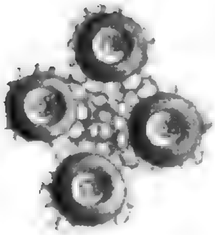

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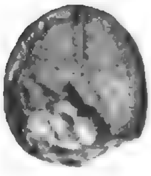

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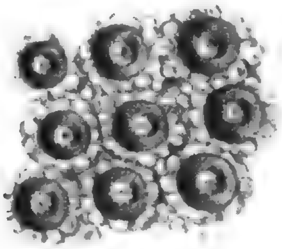

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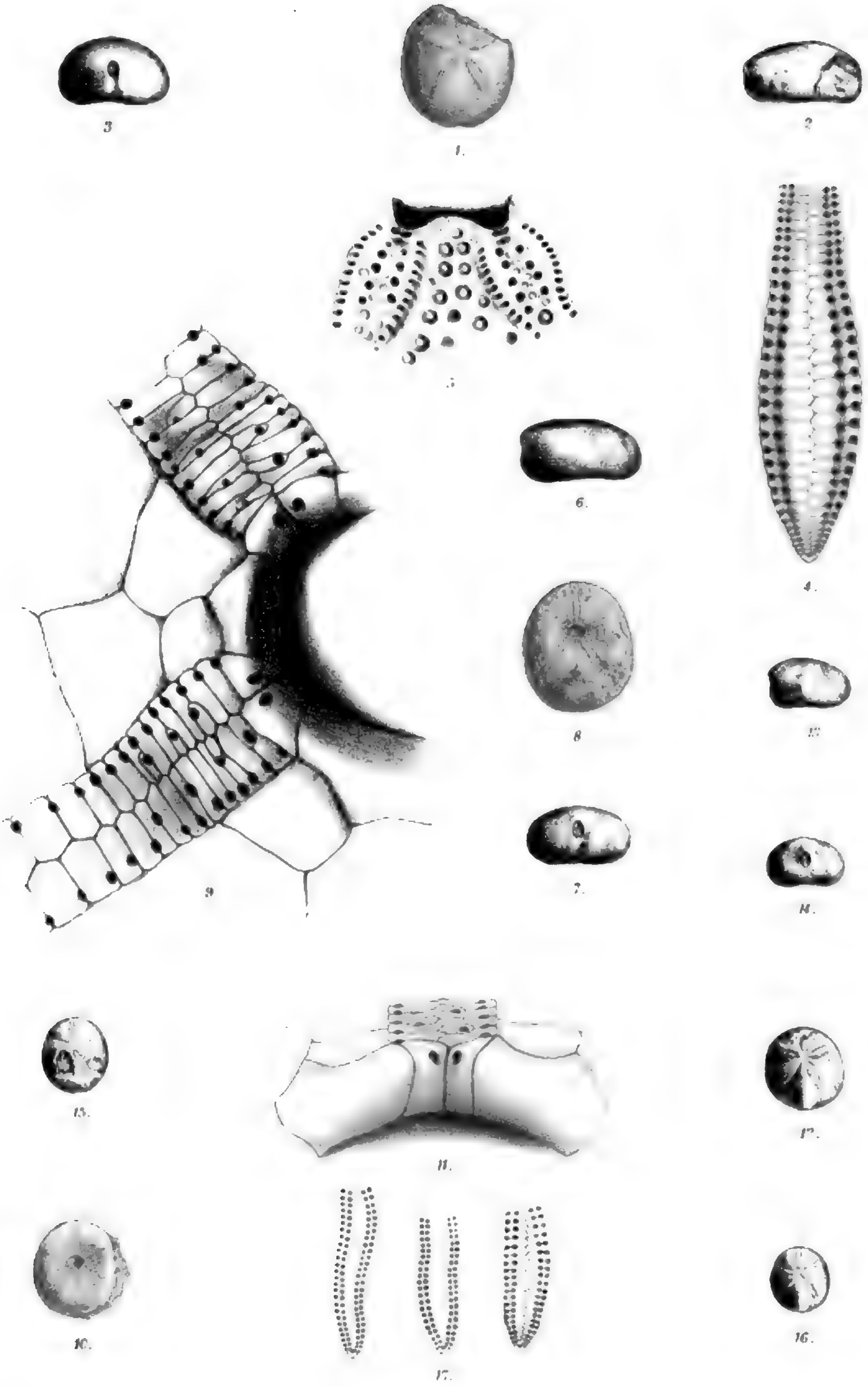
Mintern [illegible]

Fossil Echinoidea from Sind.
From below the Trap.

PLATE III.

Figure 1. Echinanthus pumilus, Duncan and Sladen (page 13). Abactinal aspect of the test, natural size.

2. Longitudinal profile of the same, natural size.
3. Transverse profile of the same, showing the posterior extremity, natural size.
4. One of the ambulacral petals, magnified.
5. The two posterior phyllodes of the floscelle, magnified.
6. Longitudinal profile of another specimen, natural size.
7. Transverse profile of the same, showing the posterior extremity, natural size.
8. Actinal aspect of another specimen, natural size.
9. Portion of the margin of the peristome of the same, showing the oral termination of the ambulacra and the formation of the phyllode, denuded of ornament, magnified.
10. Actinal aspect of another specimen, natural size.
11. Portion of the margin of the peristome of the same, seen obliquely, denuded of ornament, magnified.
12. Abactinal aspect of the test of a small specimen with well-developed keel, natural size.
13. Longitudinal profile of the same, natural size.
14. Transverse profile of the same, showing the posterior extremity, natural size.
15. Abactinal aspect of the test of a small specimen, natural size.
16. Abactinal aspect of the test of a still smaller specimen, natural size.
17. Three odd anterior ambulacra, magnified.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Duncan & Sladen dir. A. S. Foord lith.

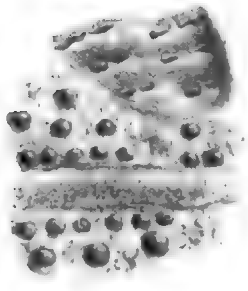
Mintern Bros. imp.

Fossil Echinoidea from Sind.
From below the Trap.

PLATE IV.

Figure 1. Linthia Sindensis, Duncan and Sladen (page 18). Abactinal aspect of the test, natural size.

2. Longitudinal profile of the same, natural size.
3. Transverse profile of the same, showing the posterior extremity, natural size.
4. Outline of the transverse profile of the test, natural size.
5. Apical system, magnified.
6. Apical extremity of the odd anterior ambulacrum, more highly magnified.
7. Portion of the test, showing the passage of the peripetalous fasciole near the extremity of a petal, magnified.
8. Portion of the test, showing the ornamentation near the lateral fasciole, magnified.
9. One of the large tubercles on the actinal surface, magnified.
10. Tubercles of the abactinal surface, magnified.
11. Profile view of the same, magnified.



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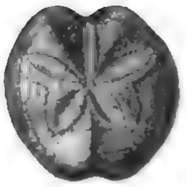

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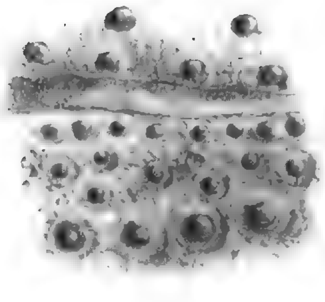

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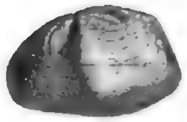

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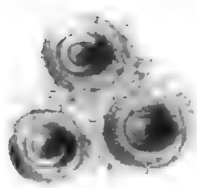

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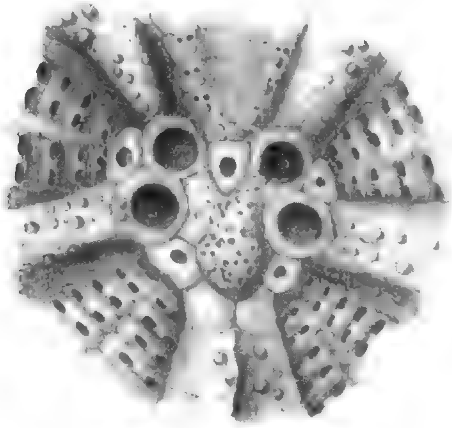

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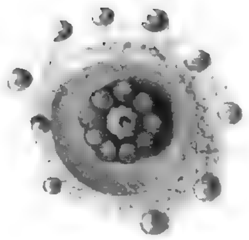

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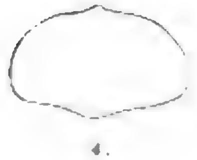

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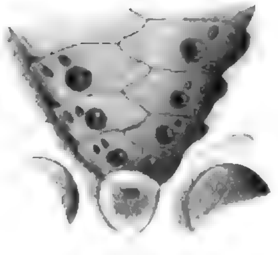

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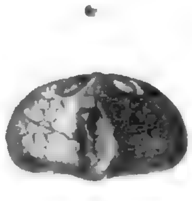

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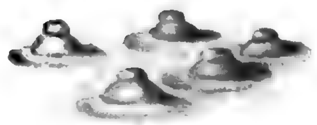

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Lawson & Sladen del. A. S. Ford lith.

Mintern Bros. imp.

Fossil Echinoidea from Sind.
From below the Trap

MEMOIRS
OF THE
GEOLOGICAL SURVEY OF INDIA.

Palæontologia Indica,

BEING

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THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL.

TERTIARY AND UPPER CRETACEOUS FOSSILS OF WESTERN SIND.
Ser. XIV.

Vol. I. 3. THE FOSSIL ECHINOIDEA.
Fasciculus II. THE FOSSIL ECHINOIDEA FROM THE RANIKOT SERIES OF NUMMULITIC STRATA IN WESTERN SIND.

WITH 16 PLATES.

BY
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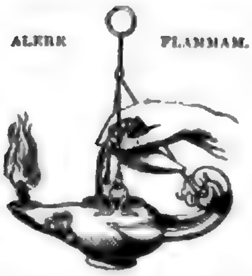
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A DESCRIPTION

OF THE

FOSSIL ECHINOIDEA

OF

WESTERN SIND.

FASCICULUS 2.—THE RANIKOT SERIES.

I. *Introductory Remarks on the Ranikot Series.*

THE stratigraphical relations and the nature of the deposits included in the Ranikot series of strata have been noticed in a former page[*], and it is only necessary to remark that the strata rest immediately on a trap which covers the *Cardita-Beaumonti* series. The lower part of the Ranikot series consists of soft sandstones, shales, clays with gypsum and lignite, and pyritous shale. These freshwater strata are succeeded by highly fossiliferous marine limestones, often brown in colour, interstratified with sandstones, shales, clays, and ferruginous bands. Nummulites appear for the first time in the succession in this series; and there is a fine fossil Coral-fauna of 50 species. The depth of the Ranikot series is 2000 feet; and it is below the main Nummulitic limestone, which belongs to the succeeding age or that of the Khirthar series.

Although the nature of the fossil Echinoidea already described from beneath the trap which underlies the Ranikot series does not give any more satisfactory evidence than the fossil Corals regarding the age of their containing strata, still an Eocene facies predominates over a Cretaceous facies in the forms of the *Cardita-Beaumonti* beds.

It is evident that the Ranikot series is very low down in the Nummulitic series, and, whilst it contains relics of a somewhat modified Cretaceous fauna, the Eocene facies predominates.

The specimens forwarded by H. B. Medlicott, Esq., F.R.S., the Superintendent of the Geological Survey, from the Ranikot series of Sind were numerous and in good condition. As was the case with the fossil Corals, we obtained little or no assistance from the work of MM. d'Archiac and Haime 'Sur les Animaux Fossiles de l'Inde,' although their types, fortunately at the Geological Society of London, were accessible. The wretched state of preservation of these forms and the diagrammatic nature of their illustrations have been a source of great perplexity to us. Wishing to give these authors every credit, and to determine their species if possible, we have constantly failed. The interesting memoir by M. de Loriol, entitled, 'Monographie des Echinides contenus dans les couches Nummulitiques de l'Egypte,' and that of Dr. W. Dames, of Berlin, 'Die Echiniden der vicentinischen und veronischen Tertiärablagerungen,' have been most useful to us indirectly as well as positively. It will be found that the fauna of this Ranikot series is a very remarkable one, and that it is as isolated as that described from Egypt by de Loriol.

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[*] Page 4, fasciculus I.

II. *List of the Fossil Echinoidea from the Ranikot Series.*

Order ECHINOIDEA ENDOCYCLICA.

Family CIDARIDÆ.

Genus CIDARIS, *Klein*, 1734.

Cidaris Verneuili, *d'Archiac*: p. 26.
—— sp.: p. 25.

Subgenus PHYLLACANTHUS, *Brandt*, 1835.

Phyllacanthus Ranikoti, *Duncan & Sladen*: p. 27.
—— Sindensis, *Duncan & Sladen*: p. 27.
—— sp.: p. 28.

Genus POROCIDARIS, *Desor*, 1854.

Porocidaris, sp.? (spine).

Family SALENIADÆ.

Genus SALENIA, *Gray*, 1835.

Salenia Blanfordi, *Duncan & Sladen*: p. 29.

Family GLYPHOSTOMATA.

Subfamily DIADEMATIDÆ.

Genus CYPHOSOMA, *Agassiz*, 1840.

Cyphosoma abnormale, *Duncan & Sladen*: p. 32.
—— sp.: p. 33.

Genus Acanthechinus, *Duncan & Sladen.*

Acanthechinus nodulosus, *Duncan & Sladen*: p. 34.

Subfamily Temnopleuridæ.

Genus Dictyopleurus, *Duncan & Sladen.*

Dictyopleurus ziczac, *Duncan & Sladen*: p. 38.
—— Haimei, *Duncan & Sladen*: p. 39, and variety, p. 40.
—— d'Archiaci, *Duncan & Sladen*: p. 41.

Genus Arachniopleurus, *Duncan & Sladen.*

Arachniopleurus reticulatus, *Duncan & Sladen*: p. 42.

Genus Progonechinus, *Duncan & Sladen.*

Progonechinus Eocenicus, *Duncan & Sladen*: p. 43.

Subfamily Echinidæ.

Section Polypori.

Genus Eurypneustes, *Duncan & Sladen.*

Eurypneustes grandis, *Duncan & Sladen*: p. 46.

Genus Æolopneustes, *Duncan & Sladen.*

Æolopneustes de Lorioli, *Duncan & Sladen*: p. 48.

Order **ECHINOIDEA EXOCYCLICA.**

Suborder GNATHOSTOMATA.

Family *CONOCLYPEIDÆ.*

Genus Conoclypeus, *Agassiz*, 1840.

Conoclypeus Sindensis, *Duncan & Sladen*: p. 51.
—— ?, sp.: p. 52.
—— declivis, *Duncan & Sladen*: p. 53.

Suborder ATELOSTOMATA.

Family *CASSIDULIDÆ.*

Subfamily Echinolampinæ.

Genus Phylloclypeus, *de Loriol*, 1881.

Phylloclypeus, sp.: p. 54.

Genus Plesiolampas, *Duncan & Sladen*, 1882.

Plesiolampas placenta, *Duncan & Sladen*: p. 54.
—— prælonga, *Duncan & Sladen*: p. 56.

Plesiolampas ovalis, *Duncan & Sladen*: p. 58.
—— rostrata, *Duncan & Sladen*: p. 61.
—— polygonalis, *Duncan & Sladen*: p. 61.

Genus EOLAMPAS, *Duncan & Sladen*.

Eolampas antecursor, *Duncan & Sladen*: p. 62.

Subfamily ECHINANTHINÆ.

Genus ECHINANTHUS, *Breynius*, 1832.

Echinanthus enormis, *Duncan & Sladen*: p. 64.

Genus CASSIDULUS, *Lamarck*, 1801.

Cassidulus ellipticus, *Duncan & Sladen*: p. 65.

Genus RHYNCHOPYGUS, *D'Orbigny*, 1855.

*Rhynchopygus Calderi, *d'Archiac*, sp.: p. 67.
—— pygmæus, *Duncan & Sladen*: p. 68.

Genus EURHODIA, *d'Archiac & Haime*, 1853.

Eurhodia Morrisii, *d'Archiac & Haime*: p. 70.

Genus PARALAMPAS, *Duncan & Sladen*.

Paralampas pileus, *Duncan & Sladen*: p. 73.
—— minor, *Duncan & Sladen*: p. 74.

Genus NEOCATOPYGUS, *Duncan & Sladen*.

Neocatopygus rotundus, *Duncan & Sladen*: p. 76.

Family SPATANGIDÆ.

Subfamily SPATANGINÆ.

Genus HEMIASTER, *Desor*, 1847.

Hemiaster elongatus, *Duncan & Sladen*: p. 78.
—— sp. (? H. digonus, *d'Archiac*): p. 81.

Genus LINTHIA, *Merian*, 1853.

Linthia indica, *Duncan & Sladen*: p. 82.
—— sp.: p. 85.

Genus SCHIZASTER, *Agassiz*, 1836.

Schizaster alveolatus, *Duncan & Sladen*: p. 87.

Genus PRENASTER, *Desor*, 1853.

Prenaster oviformis, *Duncan & Sladen*: p. 90.

Genus METALIA, *Gray*.

Metalia Sowerbyi, *d'Archiac*, sp.: p. 93.

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* Probably this species comes from a higher horizon.

III. *Description of the Fossil Echinoidea from the Ranikot Series of Nummulitic Strata in Western Sind.*

Order **ECHINOIDEA ENDOCYCLICA.**

Family CIDARIDÆ.

Genus CIDARIS, *Klein*, 1734.

The diagnosis of this genus need not be repeated in this work; but it is necessary to remark that the tubercles are usually perforate, but that they may or may not be crenulated. The pores are non-conjugate.

There are small portions of a *Cidaris* in the Ranikot group of strata, but they are not in a good state of preservation. On endeavouring to compare them with the types of the genus which were described and figured by MM. d'Archiac and Jules Haime*, we were surprised to find those carefully delineated fossils absolutely deficient in details of structure by which the species could be identified. The specimen of *Cidaris Halaensis*, d'Archiac & Haime, can be distinguished generically; but clearly the pores are non-conjugate, the tubercles are large, and the scrobicules are continuous above and below. No ornamentation or other details exist. *Cidaris Verneuili*, d'Archiac & Haime, has also a very bad typical specimen. The ambulacra are slightly wavy, the interporiferous zones are broad and have vertical series of broad roof-shaped elevations, two in each zone, and the pores are non-conjugate. In the interradia the scrobicules occupy the lower part of their plates, the median area is large, and the ornamentation is much obscured by the effects of sand-scrubbing. There are, however, more or less radiating series of separate small miliaries with furrows between them. It is with some hesitation that we place some plates in association with this species. The first specimens to be noticed do not belong to the species.

1. Cidaris, sp. Plate V, Figs. 1–3.

In the indifferently preserved specimens the perforation and faint crenulation of the interradial tubercles can be distinguished. The interporiferous zone is moderately wide; and the roof-shaped plates have, in a well-preserved part of the fossil, two miliaries or very small tubercles on them. The pores are non-conjugate. The badly preserved ornamentation of the plates beyond the scrobicular circle is small and has no tendency to be in ridges or series, or to have furrows or lines in the midst. In some places the minute tubercles are elongate and either irregularly placed or alternate.

The ornamentation of the circle itself is much worn, and was larger than that beyond, being composed of small rounded tubercles.

The scrobicules are separate above and below, and a single row of small tubercles is between them and the well-marked suture. The areolæ occupy the greater part of the plates; they are sunken near their periphery, but the bosses soon project as bold cones, the mamelon being small and perforate. The crenulation is distinct in the groove at the base of the mamelon, but it does not pass over the sides of the boss. There are from 8 to 10 pairs of tentaculiferous pores in relation to a large interradial plate.

---

* Animaux foss. de l'Inde.

Locality. Ranikot group, north by east of Petiáni, west of Kotri. Survey-number G $\frac{280}{133}$.

Illustrations of the Specimens in Plate V.

Fig. 1. An interradial plate: magnified.
2. A section of a plate: magnified.
3. A portion of an ambulacrum: magnified.

2. **Cidaris Verneuili**, *d'Archiac.* Plate V, Figs. 6–8.

Cidaris Verneuili, *d'Archiac*, 1850, *Hist. des progrès de la Géol.* t. iii. p. 246.
—— ——, *d'Archiac & Haime*, 1853, *Descrip. Anim. foss. de l'Inde*, p. 195, pl. xiii. figs. 1 *a* & 1 *b*.

Some large plates probably belong to this perforate non-crenulate form.

In the largest plate (Fig. 7) the scrobicular area occupies the larger part of the plate, and is separated from the sutural lines above and below, by the secondary tubercles of the circle and a few smaller ones beyond. These secondary tubercles are small, rather wide apart, and have bosses and mamelons. Beyond there is a circle of much smaller tubercles, which are also rather wide apart, and beyond there are irregular rows of large miliaries extending to the edges of the plates with suture-like lines between them. The whole of this ornamentation is on a convex surface which is slightly higher than the scrobicular area. The boss slopes gradually upwards and has a wide top, and a circular furrow is around the base of the mamelon. This has a constricted neck, a depressed convex top, and is largely perforate.

The width of the largest plate is $\frac{7}{8}$ inch; height $\frac{6}{10}$ inch.

Locality. Ranikot series, north-east of Petiáni, west of Kotri. Survey-number G $\frac{280}{133}$.

Illustrations of the Species in Plate V.

Figs. 6 & 7. Plates of *Cidaris Verneuili*: natural size and magnified.
8. A section of a plate (Fig. 7).

Subgenus PHYLLACANTHUS, *Brandt*, 1835.

Alexander Agassiz has pointed out that this subgenus has precedence of *Rhabdocidaris* of Desor. The group belongs to the genus *Cidaris*, and the subgeneric characters are broad interporiferous zones, pores conjugate, tubercles crenulate and perforate.

1. **Phyllacanthus Ranikoti**, sp. nov. Plate V, Figs. 9, 10.

There are fragments of three species of the subgenus *Phyllacanthus* in the Ranikot series. The specimens of one species belong to an old and younger forms, and in no case are they complete enough for a fair specific diagnosis.

What can be well observed is as follows:—

The ambulacra are slightly wavy, decidedly broad, and the poriferous zones are sunken; the interporiferous zone is at nearly the same level as the interradial plates. The pores are conjugate, and each interporiferous plate has three small tubercles on it: one, the largest of the three, is a small, broad-based one, with a mamelon, and it is situated close to the plate bearing the pores; the others are minute and separate.

The ambulacral plates are numerous, and there are sixteen in contact with a large interradial plate.

The interradial plates, well separated by sutural markings, are faintly convex, and have a large areola which occupies their larger part. The scrobicule is circular in outline, very slightly sunken at its margin, and the boss projects as a broad cone terminating in a wide apex, on which is placed a small mamelon. Crenulation occurs on the grooved apex around the base of the mamelon, which is perforate.

A circle of distinct, small, broad-based tubercles, sixteen to twenty in number, is around the scrobicule; they are decidedly larger than those of rest of the ornamentation, which consists of two kinds of small tubercles. One, rounder than the other but more or less elongate, fits in more or less between the larger tubercles just mentioned; and the other kind consists of small elongate granulations, which radiate from the scrobicular circle of larger tubercles to the sutural marking. The larger scrobicules are rather close together above and below, and they are separated by the suture and a few minute tubercles, besides the rows of larger ones. But the smaller plates carry a few large and small ornamental tubercles near the suture, on the other side of which some little amount of space is occupied by the elongate ornamentation beyond the scrobicule. The median interradial region is slightly sunken, and the ornamention is only moderate in extent. The test appears to have been rather a high one.

The scrobicular circle of separate, small, tubercles is a striking feature in this species, as is also the fact of there being six vertical rows of minute tubercles in the interporiferous zone, which, of course, is broad. The great number of pores in relation to a large plate is very remarkable.

Locality. Ranikot series, in the higher part of the gypseous marls from hills east of Lynyan. Survey-number G $\frac{288}{126}$.

Illustrations of the Species in Plate V.

Fig. 9. *Phyllacanthus Ranikoti*, sp. nov. The plates: natural size.
10. An interradial plate, with a portion of an ambulacrum: magnified.

2. **Phyllacanthus Sindensis**, sp. nov. Plate V, Figs. 11, 12.

There is a fragment of a Cidarid in the collection, consisting of four interradial plates and part of an ambulacrum, which appears to belong to the subgenus *Phylla-*

canthus, and to differ from the last mentioned. The ambulacra are broad, and there are two small miliaries, in vertical series, in the interporiferous zone of one side, and also a very minute third series. The number of pairs of tentaculiferous pores, in relation to an interradial plate, is probably about 10 or 12. The bosses of the interradial plates are well-developed, surmounted by a small mamelon, with a constricted neck, and rather depressed top, which is perforate. Crenulation is on the groove around the base of the mamelon. There is a row of small tubercles, about 16 in number, around the scrobicular circle, which is barely sunken, and beyond there are numerous smaller rounded tubercles, gradually diminishing to the size of miliaries close to the sutural edges. The scrobicules are separated from the upper and lower sutural edges by the single row of larger tubercles.

The locality of this species is in the Ranikot series, north by east of Petiáni. Survey-number G $\frac{280}{135}$.

Illustrations of the Species in Plate V.

Fig. 11. *Phyllacanthus Sindensis*, a portion of the test: natural size.
12. A plate: magnified.

Were there any pits within the scrobicular circles of these specimens, their alliance with the genus *Porocidaris* would of course be certain; but there are none.

3. **Phyllacanthus**, sp. Plate V, Figs. 4, 5.

A very much worn specimen from the Ranikot series shows very indistinct remains of furrows close to the scrobicular circle, and converging towards the base of the boss. The ambulacra are moderately broad, the pores are conjugate, and the boss is crenulate at its groove around the small perforate mamelon. The scrobicule is moderately sunken, and is surrounded by a row of small secondaries, and beyond it are many irregularly placed and smaller rounded miliaries. It is impossible to determine the species, and, indeed, there may be some doubt about the genus, for so many of the Ranikot fossils are slightly sand-scrubbed, and it is amongst the number.

Locality. Ranikot series, north by east of Petiáni. Survey-number G $\frac{280}{135}$.

Illustrations of the Species in Plate V.

Fig. 4. *Phyllacanthus*, sp., a part of the test: natural size.
5. A plate: magnified.

Family SALENIADÆ, Desor.

Genus SALENIA, *Agassiz.*

Small swollen Urchins with a small peristome, barely marked with cuts. The ambulacra are flexuous, and composed of narrow, simple poriferous plates, ornamented only with small, closely placed granules. The interambulacral tubercles are very large, crenulate and imperforate. The apical disk is compact and has an undulating contour; it is ornamented on its surface; and the sutures are usually punctured with isolated pits. There is a single suranal plate, placed in such a manner that a line drawn through its centre and the middle of the periproct reaches the other side of the anal ring and traverses an ocular and not a genital plate.

The species are Cretaceous, Eocene, Miocene, and Recent.

1. Salenia Blanfordi, sp. nov. Plate VI, Figs. 1–8.

The test is large, depressed, broader than high, flat at the abactinal surface, and narrower and slightly incurved at the actinal part, and convex at the ambitus.

The apical system is small, does not reach nearly to the edge, where the test becomes suddenly convex; it projects very slightly at the suranal plate, and is pentagonal or obscurely circular in outline. The anal opening is large, and is surrounded by a raised ring, which is highest where it is formed by the edge of the suranal plate, and lowest where the first ocular plate enters into its composition. The shape of the opening is an irregular oval. The madreporic genital plate (plate no. 2), irregularly triangular in shape, is smallest externally and broadest internally; it is of about the same dimensions as the third and fourth generative plates, being very slightly the larger. Its margins, like those of the other apical plates, are deeply and sparsely indented, and its generative pore is in the outer third; the small madreporic pit is raised and nearly central, and there is some minute pitting also. The plate does not reach the anal orifice, and is in contact with the generative plate on either side and with the suranal plate. The left anterior generative plate (the third) resembles the madreporic in its contour; it is flatter, and the pore is large. It touches the generative plates on either side, and joins the suranal by a dentate suture like the madreporic. The next plate in succession (the fourth) is of the same shape as those just noticed; and it is in contact with the suranal plate, but it does not enter the anal ring. The posterior generative plate (the fifth) is broad within, where it forms part of the anal ring, and small and pointed externally; it is shorter and broader than the others, and is unsymmetrical. Its pore is large and at the base of the ring. This plate is in contact with the plate just described (the fourth) and with the ocular plate which enters the anal system, and with the posterior edge of the suranal plate. The first generative plate resembles the fifth, and forms part of the anal ring; it is in contact with the suranal plate, and with the ocular plate (no. 1), and it is also in contact with the madreporic plate and the ocular plate (no. 2).

The ocular plates are wide and short from within outwards; they are curved within, and straighter without, with a projection pointing to the median line of the ambulacrum. They are subequal; but the first plate, the right posterior, is curved externally and broad within, and it enters into the composition of the anal ring, being united to a generative plate on either flank. The suranal plate is small, and may be slightly or decidedly smaller than the madreporic plate; it is indented at the orifice, where its margin forms a moderately developed ridge projecting obliquely; and it is in broad contact by processes with the madreporic, the left antero-lateral, and the left posterior lateral plates (that is, with plates 2, 3, and 4), and it touches by its extremities the other generative plates which enter into the composition of the anal orifice.

The suranal plate is thus in contact with all the generative plates. One ocular plate, the right posterior lateral, enters into the composition of the anal ring, and so do the two generative plates, that is to say the first and fifth.

The ambulacra are narrow, slightly wavy in their course; the poriferous zones reach from the level of the test obliquely to the interporiferous zones, which are decidedly above the level of the interradia. The poriferous zones are narrow, and their plates are numerous and about 40 in vertical series. The pores are round and well open; and one is a perforation in an ambulacral plate, and the other of the pair, placed more or less obliquely and nearer the interporiferous zone, is formed by an excavation on the edges of two consecutive plates. Each of these last kind of pores is in the line of suture of the consecutive ambulacral plates, and each is separated from the other above it by a ridge continued from the base of the tubercle on the edge of the interporiferous area. The interporiferous zone has on either side a vertical series of small secondary tubercles with minute mamelons and non-crenulate bosses; and each tubercle corresponds to a broad part of an ambulacral plate. In the median space there are two parallel, vertical rows of large miliaries, of about the same number as the secondaries, and also a few microscopic granules.

The interambulacra are wide, and occupy much space at the peristome and around the apical disk.

There are four very large, projecting primaries; and in some areas there is a fifth, but slightly smaller, primary tubercle. The larger tubercles have a large boss with a circular shoulder to it, and a broad top which is crenulate. The mamelon is small, and has a decided neck and a rather flatly rounded top.

The scrobicular circle is distinct and is composed of a few small tubercles, with still smaller ones intercalated here and there. The circle is complete between the tubercles, but not between the tubercles and the poriferous zone. An irregular row of miliaries is beyond the circle on each plate. The space occupied by the small plate in each area, near the apex, is covered with a crowd of large miliaries; and these pass into the median line, but they soon become sparsely distributed there in two rows with an occasional intercalation. Near the peristome, where the small primaries are found, the miliaries increase in number.

The peristome is rather larger than the apical system, is somewhat deeply placed, is obscurely pentagonal or nearly circular in outline, and the cuts for the branchiæ are very small. The plates are numbered in this description according to Lovén.

Height of largest test $\frac{4}{16}$ inch; breadth $\frac{7}{16}$ inch.

Locality. Ranikot series, north by east of Petiáni, west of Kotri. Survey-number G $\frac{280}{135}$.

There is a small much worn specimen of a young *Salenia* in the collection from the same locality whence the other forms came. It has large primaries; and the ambulacral plates are singularly distinct and free from ornament.

Illustrations of the Species in Plate VI.

Fig. 1. *Salenia Blanfordi*, Duncan & Sladen. The test: natural size.
2. The apical system and upper surface: magnified.
3. A larger specimen, showing the actinal surface: slightly magnified.
4. The abactinal surface; magnified.
5. A specimen: natural size.
6. A portion of an ambulacrum: magnified.
7. Three plates of the interradium: magnified.
8. A young specimen: magnified.

This species of *Salenia* was especially noticed by Mr. W. T. Blanford, F.R.S., during the Survey of Sind, and he was good enough to examine it and to send a description of it to us. He noticed the remarkable smallness of the apical disk, and that one of the ocular plates enters the anal ring. These are the two distinctive characters of the form, which distinguish it from the European Nummulitic *Salenia Pellati*, Cotteau, and *Salenia tertiaria*, Tate, of the Miocene of Australia.

Family GLYPHOSTOMATA.

Subfamily DIADEMATIDÆ.

Genus CYPHOSOMA, *Agassiz*, 1840.

Test moderate in size, circular or subpentagonal, slightly inflated at the sides. General facies of test shows a regular and uniform development of its parts.

Poriferous zones well developed and undulated.

Pores simple, usually unigeminal throughout, sometimes bigeminal on the upper surface, and slightly crowded together around the peristome. The poriferous plates are unequal and irregularly arranged.

Primary tubercles nearly equal in both areas. Areolæ well developed and sometimes marked with radiated striations. Bosses prominent, summits sharply crenulated. Mamelon large, prominent, and imperforate.

Peristome moderate in size and with small cuts.

There are five specimens of a regular Echinid which come from the Ranikot series of Sind, and they are in a good condition. Four of the specimens belong to one species; but there is some doubt about the similarity of the fifth to them, notwithstanding the allowances that may be made for its being the youngest and smallest of the forms.

The species belong to the genus *Cyphosoma*, Agass.; but they are somewhat abnormal, on account of the want of correspondence in size between the ambulacral and interradial primary tubercles, the last-mentioned being decidedly the larger. The other structural characters clearly bring the forms within the generic idea; and therefore they are placed in it, especially as some variation between the dimensions of the tubercles of both areas has been noticed in some species in Europe.

1. Cyphosoma abnormale, *Duncan & Sladen*, sp. nov. Plate VII, Figs. 1–7.

The test is depressed, circular in marginal outline, very bulging at the sides, nearly flat at the abactinal surface, and slightly concave actinally, notwithstanding some convexity of the areas around the rather small sunken peristome.

The apical system is small; details not preserved.

The ambulacra are comparatively narrow, and enlarge moderately only, at the ambitus; they are not quite one half of the breadth of the interradial areas at the most convex part of the test, and the broad poriferous zones are on a slightly lower level than the interporiferous areas.

The pores are very small and numerous, bigeminal, and more or less in arcs from the ambitus to the apical system, and in slightly arched simple series near the peristome.

At the ambitus the ambulacral tubercles are larger than elsewhere, and they diminish in size more suddenly towards the peristome than towards the apex, and they are less numerous in the former direction. The larger tubercles have a broad circular base; the boss slopes gradually upwards to a well-developed neck, which is surmounted by a small mamelon, rather flattened at the summit and imperforate. The crenulation is distinct. A scrobicular circle of a few large and small miliaries is around each tubercle; and near the poriferous zone the larger of these miliaries are in relation to a poriferous plate, a line of depression intervening between the successive miliaries. A small secondary tubercle is seen, here and there, at the ambitus, and usually they are placed, solitarily, between the vertical series of larger tubercles. Near the apex the tubercles are small, and the circle of smaller tubercles is ill-defined; but there are a few tubercles of intermediate size in vertical series. Still nearer the ambitus the tubercles are larger, and begin to assume the character of those at the ambitus. Near the peristome there is a short close vertical series of small tubercles of intermediate size, followed by wider-apart ones, which gradually become typical tubercles. In the close series the scrobicular circle of miliaries is not seen; but it commences directly there is any appreciable distance between the tubercles.

The interradial areas are wide, even at the apex; and their tubercles are small away from, and large and projecting at the ambitus; they are larger than those of the ambulacra. A large tubercle at the ambitus, has a broad base, a slanting conical boss, which is broadly crenulate, with a large and narrow neck and a small, rather flat mamelon. The scrobicular circle, of a single row of large miliaries, is incomplete between the vertical series of tubercles, but nearer the apical system it is nearly complete. There, the tubercles are wider apart, and the miliary circle is sparsely furnished. At the actinal surface the tubercles are larger than at the apex, and the scrobicules of the vertical series are not separated.

The median area of the interradials is wide and very sparely ornamented with large and small miliaries near the apex, a very few small tubercles with crenulated bosses being placed in alternate vertical series near the median line of suture. They are largest at the ambitus.

Between this series and the scrobicular circles are large miliaries, many with a sharp point; they form rather indefinite scrobicular circles around the small tubercles; and others are dotted about here and there, sparingly. Hence the ornamentation is distinct, sparing, and unequal in the median area, and it passes in arcs on one side of the great tubercles.

Between the scrobicular circles of the interradials and the poriferous zones, the ornamentation consists of a vertical series of small tubercles, unequal in size, and of a few large miliaries. This ornamentation diminishes near the apical system, and a few miliaries are seen near the poriferous zones. A similar diminution occurs near the peristome in the ornamentation of this particular region. There are traces of an indefinite ribbing down the flanks of some of the bosses of the interradial area, near the poriferous zones.

Dimensions. Breadth of the specimen $1\frac{3}{10}$ inch; height rather more than $\frac{1}{2}$ inch.

Locality. North by east of Petiáni, west of Kotri. Ranikot series. Survey-number G $\frac{280}{135}$.

A second specimen is smaller than the type and evidently younger. The height is $\frac{1}{2}$ inch, and the breadth $1\frac{2}{10}$ inch. The ornamentation is less elaborate than that of the type; but the large miliaries of the plates near the apical system, in the interradia, are better defined in their circular arrangement. The specimen came from the same deposit as that just described.

A small form clearly belongs to this species; and the principal distinction is one of age, and relates to the ornamentation, which is more scanty.

Further, a small form has to be noticed; and its value is in the preservation of the peristomial margins. The peristome is small, and the cuts are very small. The poriferous zone is simple, and the more or less arched series of pores is unigeminal, except in one or two spots near the apex in some zones. It is from the same locality; and the dimensions are, breadth $\frac{7}{10}$ inch and the height $\frac{4}{10}$ inch.

Illustrations of the Species in Plate VII.

Fig. 1. *Cyphosoma abnormale*, Duncan & Sladen. The side view of a large specimen: natural size.
2. The abactinal surface: slightly magnified.
3. A small specimen: magnified 2 diameters.
4. An ambulacrum of the large specimen: magnified.
5. The interradial tubercles, near the ambitus, of the smaller specimen: magnified.
6. The poriferous zone and the adjoining ambulacral and interradial plates, near the peristome, of the larger specimen: magnified.
7. An interradial plate of the large specimen: magnified.

2. CYPHOSOMA, sp. Plate VII, Figs. 8, 9.

A small specimen of a rather worn *Cyphosoma* is in the Ranikot series collection, and is from the same locality as the other forms. Its tubercles are small, and there is not much distinction in size between those of the different areas. The pores are in arcs and in simple series, and the ornamentation is very simple. Possibly it may be a young specimen of the species just described.

The breadth is $\frac{6}{10}$ inch, and the height is not quite $\frac{3}{10}$ inch.

Illustrations of the Species in Plate VII.

Fig. 8. The test: natural size.
9. A poriferous zone and adjoining areas: magnified.

There are two fragments of a test of a *Cyphosoma* from the locality which yielded the more perfect specimens. One is part of a large form of the species just described; and the other belonged to a large test of another species. This test is characterized by the elaborate ornamentation which exists between the vertically placed tubercles, whose scrobicular circles are distinct. The intervening space is ornamented with small tubercles, with mamelons and indefinite scrobicular circles of miliaries, and with some large and small miliaries, which are irregularly placed.

Genus ACANTHECHINUS, gen. nov.

A large fragment of a regular Echinid allied to the Diadematidæ, without apical and actinal portions, and showing one half of the rest of the test, is in the collection from the Ranikot series. The details of the structures of the test are unlike those of any known genus. The description of the specimen can only relate to the general shape and the details of the ambulacral and interradial areas.

We propose to include this form as a new genus; for although it has some of the characters of *Stirechinus*, Desor[*], there are generic distinctions to be observed between them.

Test turban-shaped. Ambulacra convex from side to side, one half the breadth of the interradial areas, with two incomplete vertical rows of primaries. Pores in numerous pairs, forming a double series near the apex only. Interradials with sunken median areas, plates distinctly sutured and high. Primary tubercles of both areas well developed, some on raised areolæ, all with a broad-based tumid boss and a small mamelon; they are imperforate, but largely crenulate, with ridges passing down their flanks. Secondaries or large miliaries sharply pointed and spiny.

The species may be called *Acanthechinus nodulosus*.

1. Acanthechinus nodulosus. Plate VIII, Figs. 1–3.

The original shape of the test was probably turban-shaped, or depressed and circular, or subpentagonal in marginal contour. It was flat actinally, bulged at the ambitus and for a short distance above, and it sloped gradually upwards to the apex, being less convex there.

Compared with the interradials, the ambulacral areas are small, but nearly as prominent. At the ambitus the width of the ambulacrum is not more than that of one half of the interradial area. The ambulacra are narrow, and are convex from side to side. There are a few primaries in the interporiferous zone. They are small at the apical end, enlarge gradually towards the ambitus, and cover much of their plates there. They are in two alternate vertical rows, and have broad bases, tumid bosses, and small mamelons. The bosses are crenulate, and also ridged down their flanks; they are upon slightly raised areolæ, which are marked with linear depressions and intermediate ridges in connexion with the poriferous plates. The sutures between the plates of the interporiferous zones are distinct; and between them and the base of the mamilliform processes are a few large miliaries in an incomplete circle, and they are sharply pointed or nodulose, and are usually oblique in their direction. The crenulation takes on the form of nodules more or less sharp, and ridges with intermediate furrows, and there may be pointed granules on the bosses. The small mamelon has a constricted neck and is imperforate.

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[*] Desor, 'Synopsis des Echinides Fossiles,' p. 131. *Stirechinus Scillæ*, Desor, = *Echinus Scillæ*, Desm., from the Pliocene of Palermo and Monte Mario.

Every plate of the interporiferous zone has not a primary tubercle on it, and there are small wedge-shaped plates between the tubercle-bearing ones in vertical series. Hence the tubercles are rather wide apart, one above the other. The intermediate plates are furrowed at their edge in the direction of the poriferous plates, and they have a few oblique and sharp-pointed miliaries on them. They have well-marked sutures, and are comparatively smaller at the ambitus than near the apex.

The poriferous zones are narrowest actinally, and slightly largest near the apex: they are placed obliquely on the test, on the lateral slopes of the ambulacra. The number of plates is considerable, and there are from 10 to 17 in contact with the larger interradial plates. The pores are crowded vertically, but only form a double series near the apex, although there is much close alternation or serial succession elsewhere. Near the actinostome they are in single vertical series. They are conjugate, small, slightly elliptical or round; and each plate has raised margins above and below, which form between them hood-shaped openings and tubular furrows. These margins become broken ridges in some places, and may have a miliary tubercle upon them. The number of pairs differs in relation to the primary ambulacral plates, and there are often five or eight pairs.

The interradial areas are large, have their sutures very visible, the median space sunken, and the projecting centre of each plate occupied by a very projecting large primary, which is flanked by a surface on which are placed a few spiniferous large miliaries, and some small miliaries here and there.

The bosses are placed on raised scrobicules, surrounded by a more or less complete circular furrow; they are tumid cones, with a broad apex and wide base, are furrowed and ridged on the flanks, and crenulate and nodular above. The mamelon is small, has a tall constricted neck, and is therefore high; it is imperforate. There are eight plates from the ambitus to the apex, in each half of the area; and they are very broad near the margin, and diminish in breadth, and increase slightly in height, towards the apical system.

The length of the test is $\frac{8}{10}$ inch; the greatest width of the ambulacra $\frac{7}{30}$, and of the interradial areas $\frac{5}{10}$ inch.

Locality. In the Ranikot series, hills east of Lynyan, from the brown limestone. Survey-number G $\frac{126\times}{380}$.

Illustrations of the Species in Plate VIII.

Fig. 1. *Acanthechinus nodulosus*, Duncan & Sladen. The remains of the test. natural size.
2. Ambulacral and interradial plates at the ambitus: magnified.
3. A primary tubercle: magnified.

Subfamily TEMNOPLEURIDÆ.

This subfamily, on account of the late discovery of other fossil and recent forms than it formerly comprehended, must be considerably enlarged. A critical examination of the genera and species hitherto included in the subfamily, and a careful morphological study of one group of the genera, necessitate its division into two groups, which probably may each form a subfamily. It is unfortunate that the genus *Temnopleurus*, which is not represented by species in the Nummulitic series, and which is apparently a recent development, should have given the name to the subfamily, many of the genera of which are found fossil. The morphology of the test of the genera *Temnopleurus*, *Salmacis*, *Amblypneustes*, and *Pleurechinus* * is peculiar, and the true pits at the sutural angles undermine the test, whose plates are united by knob and socket suturing. These morphological details are not found in *Temnechinus* and the forms found fossil in the Nummulitic of Sind, although some of them have been classified as species of *Temnopleurus*.

Nothing is more distinct than the structure of the outside of the test of the genus *Temnechinus*, and the genera we associate with it, and that of the genus *Temnopleurus* and the genera already noticed in relation to it. In the one the raised ornamentation produces the appearance of depressions along the whole line of the sutures, especially of the horizontal sutures; and in the other there are, besides, deep pits at the sutural angles and a special method of union of the plates. The structure of the apical system is peculiar in some of the genera associated with *Temnechinus*, and differs from that of *Temnechinus* itself. The apical system of the Temnopleurids with true pits appears to be tolerably uniform, and to be fashioned upon the plan of *Temnechinus*. Crenulation and non-crenulation of the tubercles exist in both of the groups.

We have had the advantage of examining a very perfect specimen of a *Glyphocyphus* from the Upper Greensand of England, and also of studying the plates of other species drawn under the direction of Cotteau and Wright. Our form is clearly of the subfamily Temnopleuridæ; but it does not belong to the group with true sutural pits, but to that with Temnechinid sutural depressions.

The diagnosis of *Glyphocyphus* is given in d'Archiac and Haime's 'Animaux

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* P. Martin Duncan, Journ. Linnean Soc. vol. xvi. p. 243, 1882, and ibid. p. 448.

Fossiles de l'Inde.' It includes small urchins, more or less swollen, with straight and simple poriferous zones. The peristome is small and sunken, and the apical disk narrow and annular. The tubercles are small, usually not very distinct, and are crenulate and perforate; they arise from the midst of a close miliary granulation, which forms a kind of star around each tubercle. The interambulacral plates have their sutural lines distinct and even slightly grooved, so as to give the test a sculptured appearance. Desor is mistaken in asserting that the tubercles are neither crenulate nor perforate. In the delineations of Goldfuss of the species nothing can be made out satisfactorily; but in Desor's pictures of *Glyphocyphus radiatus* the whole of the ocular plates come into the oral ring, and the primary tubercles have a vertical ridge uniting them. The tubercles are perforate and crenulate in British specimens, and in *Glyphocyphus conjunctus* (the *Arbacia conjuncta* of L. Agassiz) the whole of the tubercles are united by elongate granules, but the aboral lines are not so distinct as in the type of the genus. In *Glyphocyphus Neocomiensis*, Cotteau, the tubercles are both crenulate and perforate.

Glyphocyphus may be considered to be the type of the group of which *Temnechinus* forms a part.

In the Ranikot series of Sind, which is at and above the base of the Nummulitic strata, several remarkably ornamented Echini have been found by the Geological Survey of India under Messrs. Blanford and Fedden.

Others had been discovered many years since and were sent to MM. d'Archiac and Jules Haime for description in their great monograph 'Sur les Animaux Fossiles de l'Inde.' They were described in that work and figured, and were returned to the Geological Society of London. The descriptions are long, and the drawings are exquisitely definite; but the specimens themselves are not in a condition to satisfy us even about their generic position, from the light cast upon them by the beautiful specimens belonging to forms from the same area and in our hands.

We are not satisfied that they have true pits at the sutural angles; and it appears to us that the various species are members of one of the groups typified by *Glyphocyphus* of the subfamily with raised ornamented ridges and depressions over the sutures.

The drawings in 'Les Animaux Fossiles' have misled Desor and A. Agassiz; and in the report on the 'Challenger' Echini there is an exquisite drawing by this last-mentioned author of a *Pleurechinus*, which he compares with *Temnopleurus Valenciennesi*, D'Archiac & Haime. In *Pleurechinus bothryoides* of Japan the ornamentation is raised, and the sutures are distinctly penetrated by a deep depression at the angle of the plates. It is a true Temnopleurid. But an examination of the type from Sind drawn by Messrs. d'Archiac and Jules Haime proves that it was so weathered that the imagination of the draughtsman was founded on miserably defective structural details. The drawing in the plate of the great work is absolutely a restoration. No deep pits are to be seen at the angles.

The specimens of Echini with raised ornamented ridges and without penetrations at the angles of the sutures, and which were derived from the Ranikot series of Sind, are numerous. Some are beautifully preserved, others are so in parts, and a few have been so weathered and worn that they might almost be placed in different genera.

The well-preserved specimens indicate clearly that they have a most elaborate raised ridge-like ornamentation, and no sutural depressions and penetration; and the badly-preserved ones have the appearance of deeply-bevelled sutures, and as if the test had been cut out, instead of added to, in thickness.

Genus DICTYOPLEURUS, gen. nov.

The test is small, hemispherical above, slightly concave below, with a small peristome and small cuts. The pairs of pores are in continuous straight series. The tubercles of both areas are very small. Those of the ambulacra are in two vertical series close to the pores, and each tubercle is united by a vertical raised ridge with those above and below, and by a zigzag of raised ridges with those of the other vertical series opposite. The tubercles of the interradial areas, in two vertical series, are on vertical raised ridges or ribs. Each tubercle is continuous with two of the opposite series by a raised ridge, and sends off two or three ridges to the poriferous zone. The tubercles are faintly perforate and slightly crenulate, and there are indications of a few secondaries around them. The perforation and crenulation is indistinct in the ambulacral areas. Here and there the narrow raised ribs have small granules upon them. The sutural lines of the plates are distinctly seen, and there are no depressions or penetrations of them. The apical system, obliquely placed, is elongate; and one ocular plate enters the anal ring.

1. Dictyopleurus ziczac, *Duncan & Sladen*. Plate IX, Figs. 1–3.

The test is small, hemispherical above the rather tumid ambitus, which is circular in outline, and slightly concave actinally, where there is a small sunken peristome with slight cuts.

The apical system is large for the size of the test, is placed obliquely, and the anus is elongate and elliptical in outline. The direction of the long axis is as in an *Echinometra*. The ring of generative plates is narrow; and one ocular, the right posterior, enters into the composition of the anal ring. The madreporic body rises like a small knob, and its plate is the largest; none of these plates enter far into the interradial areas. The ocular plates have triangular depressions on their sutures on either side of a vertical line, and the pore is visible near the apex of the blunt angular projection.

The ambulacra, about one half of the breadth of the interradials at the ambitus, have two vertical series of small tubercles on narrow, raised, rounded ridges, placed close to the poriferous zones. The tubercles are small, very faintly perforate and crenulate, and they increase in size and number actinally. The interporiferous zone is crossed by a zigzag of raised ridges, which unite the opposite and alternate tubercles on the vertical ridges. Much of the surface of the plates is seen on either side of the ridges, and the sutural lines are distinct; these cross over the ridges in young specimens. The pairs of pores are in single rows, and there are three pairs opposite each interradial plate; they are rather large, and some perforate the ridge which passes from the ambulacral raised ridge to that of the interradial area. The interambulacra are broad, and have two vertical, narrow, raised ridges, on which are placed the twelve small primary tubercles. The ridges are rounded, sometimes have a single granule here and there; and the tubercles are largest near the ambitus, being very faintly perforate and crenulate, and occasionally surrounded by a circle of small miliaries. The median interambulacral space is occupied by a zigzag of slightly curved, narrow, rounded ridges, smaller than those of the vertical series, and extending from the tubercles of one series to those of the other in oblique paths. These ridges sometimes carry a large granule or two.

The coronal plates are very visible between the cross ridges, and the sutural lines are very distinct. Like those of the ambulacra, the sutures do not mark the ridges in the larger specimens, but they cross them in the younger. Between the interradial tubercles and the ambulacra there are groups of two or three ridges passing obliquely off from each tubercle; these pass between the poriferous plates, and are sometimes perforated by the pores, and finally unite with the adjoining vertical ridge of the ambulacrum.

Height of test $\frac{3}{10}$ inch, breadth $\frac{3}{10}$ inch.

Locality. North by east of Petiáni. Ranikot series. Survey-number G $\frac{280}{135}$.

Illustrations of the Species in Plate IX.

Fig. 1. The test of *Dictyopleurus ziczac*: natural size.
2. The apical system: magnified.
3. An ambulacrum and interradial area: magnified.

2. Dictyopleurus Haimei, sp. nov. Plate IX, Figs. 4, 5.

The test is small, tumid at the ambitus, which is circular in outline, conical above, rather flat actinally, and sunken at the small peristome. Apical disk wanting, but its direction appears to have been oblique. The ambulacra are much narrower than the interradial areas; the poriferous zones are narrow, and consist of a continuous single series of pairs of pores, which usually penetrate ridges connected with the interradial tubercles. There are three pairs of pores to each interradial plate. Immediately within the series of pores is an indistinct raised ridge; it is vertical, thin, straight, and discontinuous, here and there carrying very small tubercles; these are largest near the actinal surface, and have swollen bosses and small mamelons. Crossing the space, in the interporiferous region, between these vertical ridges is a series of oblique narrow ridges, sometimes linear, at others thicker, and ornamented with one or two rows of miliaries. These pass from one tubercle to those of the opposite series above and below; and there is distinct space between them in which the sutures can be seen. Here and there the zigzag becomes disorderly.

The interambulacral areas have two vertical narrow ridges, one on each coronal series; they are more or less discontinuous where the small crenulate and perforate primaries exist. These are in slightly sunken scrobicules. Actinally the scrobicules are in contact with the vertical ridge, which usually has a row of miliaries on it. On either side, and abactinally to the scrobicule, is a raised ornamentation (on the base of which rests the scrobicule) extending on either side, and marked with two or three horizontal rows of miliaries. Towards the ambulacrum this ornamentation divides into three ridges, which are continuous with the poriferous plates, and towards the median line into two ridges, which unite with those of the tubercles above and below of the neighbouring column. The ridges are narrow and miliary, and the spaces between them, and on the bottom of which the coronal plates and distinct sutures are seen, are elongate transversely, being crossed vertically by the raised ridge between the small primaries.

There are no penetrations of the test at the sutural angles. Actinally the spaces between the ridges become deeper and smaller.

Height of the test $\frac{3}{10}$ inch, breadth at the ambitus $\frac{4}{10}$ inch.

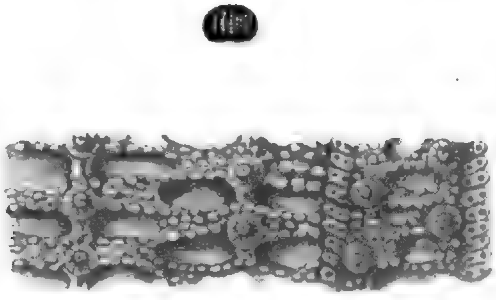
Locality. Hills east of Lynyan, from brown limestones. Ranikot series. Survey-number G $\frac{280}{127}$, G $\frac{280}{128}$, G $\frac{280}{133}$.

Illustrations of the Species in Plate IX.

Fig. 4. *Dictyopleurus Haimei*, Duncan and Sladen: natural size.
5. Part of an ambulacrum, and interradial area: magnified.

DICTYOPLEURUS HAIMEI, *Duncan & Sladen*, variety.

There are some small specimens of this species in the brown limestone whence the type was derived; and they seem almost to unite the species *Dictyopleurus costatus* and *Dictyopleurus d'Archiaci*. They would be considered young forms of *Temnopleurus*, and might be classified with one of the species of that genus described by MM. d'Archiac and Jules Haime; but they are not members of the genus *Temnopleurus*.



Dictyopleurus Haimei, var.

The main distinction of these specimens from the type of *Dictyopleurus Haimei* is that the bands of transverse raised ornamentation on the interradium are not so split up and are higher; the bands unite along the median line by short processes, or their angles join. The distinction from *Dictyopleurus d'Archiaci* is, that in the variety there is a vertical line of raised tissue in the interradium on either side, connecting the vertical row of tubercles together. The test is very thick; and the transverse depressions over the sutures are deep and much broader than high. There are no pits in the test at the sutural angles.

3. Dictyopleurus d'Archiaci, sp. nov. Plate X, Figs. 5–8.

The test is small, conico-turban-shaped, swollen at the ambitus, and sloping gradually to the apex with a gentle curve. The actinal part is rather flat but slightly convex, and the actinostome is sunken and small. The apical system is deficient.

The ambulacra are narrow, the poriferous zone slightly sunken; and the pores are in simple vertical series, and about three to each interradial plate; they are on slight ridges. The interporiferous zone has a ribbed ornamentation which crosses it, leaving rather irregularly-shaped depressions on either side of the median line; these are deep, square, or irregularly oval and triangular spaces, and are largest above the ambitus. There are also transverse linear depressions; the number of plates is considerable, and the ridges on them are of different lengths. A vertical row of small primaries is on either side just within the poriferous zone; and the tubercles are raised on the ridges, have a tumid boss and a small mamelon; they are faintly crenulated. A close ornamentation of large miliaries, some of which are very distinct, covers the ribs of the ornamentation. The interradial areas are marked with well-developed ornamented transverse ridges leaving rectangular furrows between them, whose transverse continuity is arrested by the primary tubercles. The ridges are broad and high; moreover they project well from the test; they are rectangular, have their actinal edges slightly wavy, and are ornamented by three transverse rows of well-developed miliaries. Each one is connected with the ambulacral poriferous plates by a narrow short ridge, and with its fellow, on the opposite side of the median line, by a very short process from each upper and actinal angle. There are two vertical rows of primary tubercles on the interradial areas, and a primary is thus situated in the midst and towards the actinal edge of the ornamented ridge. It is large for the dimensions of the plate, is surrounded by a linear scrobicular circle, and has a tumid boss and a small mamelon. Crenulation and perforation exist. The actinal edge of the tubercle impinges on the plate below; but no vertical ridge is observed in the perfect form.

Height of specimen $\frac{1}{4}$ inch, breadth $\frac{7}{10}$ inch.

Locality. Hills east of Lynyan, from brown limestones. Ranikot series. Survey-number G $\frac{280}{127}$.

The specimen which has been taken as the type has been weathered, except close to the supporting piece of rock, and the furrows over the lines of the sutures are very distinctly shown. In the ambulacra, the larger plates which supported the primary tubercles are projecting, and there is a vertical ridge between the raised ridges of the interradial areas in relation to the primary tubercles.

Another specimen, which has been well weathered, shows these points more distinctly, and is delineated on Plate X, Figs. 7 & 8.

Illustrations of the Species in Plate X.

Fig. 5. *Dictyopleurus d'Archiaci*: natural size.
6. A portion: magnified.
7. A weathered specimen: natural size.
8. A portion: magnified.

Genus ARACHNIOPLEURUS, gen. nov.

The test is circular in marginal outline, depressed, tumid at the ambitus, and rising but slightly above it. Peristome deeply sunken and small, and cuts small. Apical system large, deficient in details. Ambulacra narrow; pores uniserial, in slight curves, penetrating ridges which are continuous with tubercles on the scrobicular circles. Tubercles small, in vertical series, perforated and crenulate, with very large scrobicules raised above the test; small secondaries in a single row on the raised scrobicular circle, and radiating ridges connecting them with the boss. Small nodulose ridges or ribs uniting the secondaries of each vertical series to those on the scrobicules of the adjoining vertical series and also to the poriferous zone. Plates and sutures visible between the ridges.

1. ARACHNIOPLEURUS RETICULATUS, sp. nov. Plate IX, Figs. 6–8.

The test is small, depressed, faintly conical abactinally, depressed actinally, with a small deeply-sunken peristome with small cuts.

The ambulacra have two rows of small perforate and crenulate tubercles situated close to the poriferous zone. They are largest at the ambitus, and very small near the apical system. Inferiorly they are closer together than abactinally, and better developed. A tubercle at the ambitus has a disk-shaped scrobicule elevated above the mean height of the test; and ridges rounded and narrow, but long and shallow, in the form of costæ radiate from the base of the boss. One passes abactinally; and another actinally crosses the scrobicule, and reaches its margin, where it may unite with a corresponding one from the tubercles in vertical series; or it may unite with some confused costæ having large miliaries on them. On either side of the boss three or four costæ radiate laterally, one set, the longest, joining the costæ of the two tubercles of the neighbouring ambulacral plates, and the other, the shortest, pass to the poriferous zone close by. Each costa is perforated by a pair of pores. A few knobs or large miliaries are on the costæ here and there; and there are spaces between the costæ, large and oblique in the median area, and wide between each successive boss. The plain surface of the test is seen at the bottom. Near the actinostome the tubercles and costæ become rather crowded, and the spaces between the costæ simulate (but are not) pits in the test. The pores are in one series, and occupy but little space.

The interradial areas are wide, and have two vertical series of small perforate and crenulate tubercles rather widely apart. The tubercles are larger than those of the ambulacra, are largest at the ambitus, and are most crowded towards the peristome, where they rapidly diminish in size. The costæ radiate from the base of the boss, cross the scrobicule, and have a miliary tubercle on them at the circle-edge. Three or four costæ placed close together in a band, unite the tubercles of the same vertical series, and two bands of two or three costæ, each ornamented with a miliary, pass off obliquely to unite with corresponding costæ from the two opposite tubercles. Four or five costæ pass to the poriferous zone, having miliaries here and there, and they join the perforated costæ of the ambulacra.

Other costæ occur in the intervals between all these and the bands, and thus a zigzag series of narrow, shallow, and broad spaces is produced. The peristome is very small, and the cuts also.

Height of the specimen $\frac{4}{10}$ inch, breadth $\frac{8}{10}$ inch.

Locality. North by east of Petiáni, west of Kotri, in the Ranikot series. Survey-number G $\frac{280}{133}$.

Illustrations of the Species in Plate IX.

Fig. 6. *Arachniopleurus reticulatus*, Duncan and Sladen: natural size.
7. Part of an ambulacrum and interradium: magnified.
8. Some ridges near the apical disk: magnified.

Genus PROGONECHINUS, gen. nov.

Test of small size, moderately high, subconical above, concave beneath, margins tumid.

Poriferous zones straight, pores arranged in simple continuous series throughout. Ambulacral plates with three pairs of pores directly superposed. Interporiferous areas with two vertical series of primary tubercles placed marginal; additional primaries occurring on the plates near the ambitus; the rest of the plate occupied with granules. Interradial plates with groove-like slits at the inner extremity of the horizontal sutures. Interradial areas with two continuous vertical series of primary tubercles, the plates at the ambitus with two or more companion primaries in horizontal line, the vertical series of these being not continuous. The primary tubercles of both areas are neither crenulate nor perforate; those of the interradia are slightly longer than the ambulacral tubercles, and are sunken in deep scrobicules. Granulation coarse and unequal, with a tendency to become confluent around the tubercles. Some larger granules with mamelons. Apical system unknown.

Peristome subcircular, with rather deeply incised slits, with margins thickened and reverted.

1. PROGONECHINUS EOCENICUS, *Duncan & Sladen.* Plate X, Figs. 1–4.

The test is depressed, swollen at the ambitus, and sloping convexly to the apex. The actinal margin is rather pentagonal, the median interradial and ambulacral vertical lines are slightly depressed, and the spaces on either side are rather tumid. The extra tumidity of the ambulacra produces the peculiar marginal outline. Below, the test is slightly concave.

Apical system wanting. The peristome is rather large, slightly pentagonal, and the cuts are distinct.

The ambulacra, about one half of the breadth of the interradial areas, have three pores in a slight depression arranged in simple vertical series, about four being in relation to an interradial plate. There are three poriferous plates to each whole compound ambulacral plate, and the sutures are very distinct. The adoral poriferous plate is short and band-like, extending the whole length of the ambulacral plate; the median plate tapers wedge-like inwardly, and is not more than two thirds of the breadth of the column; and the aboral poriferous plate is large, and might from its shape be compared to the primitive plate of an echinid ambulacrum. The plates are placed rather obliquely, and are more or less granular. Near the apex there is one small primary on each of the larger plates; near the ambitus there are two; and close to the actinostome there is but one, and it is larger there than elsewhere.

In the interradial areas the median depression is evident, and the broad and rather low coronal plates show sutural grooving, and near the angle the appearance of a slit-like pit.

At the ambitus the ornamentation consists of three small primaries or scrobicules surrounded by miliary granulation, which partly forms circles around the areas, and a confused intermediate ornamentation. Abactinally the number of primaries on each plate diminishes until only one is seen; and actinally they also diminish in number, become larger until close to the peristome, and have distinct scrobicular circles. Extending from these larger primaries on the actinal surface to some small primaries near the pores are zigzag ridges.

The tubercles of the interradial plates have a flat boss and small mamelon, and are imperforate and non-crenulated. The cuts have a raised elongate ridge around them.

Height of the specimen $\frac{8}{10}$ inch, breadth $\frac{11}{10}$ inch.

Locality. Uncertain; but the colour and nature of the fossilization indicates the dark-brown Ranikot limestone. Survey-number G $\frac{260}{138}$.

Illustrations of the Species in Plate X.

Fig. 1. *Progonechinus Eocenicus*, Duncan and Sladen: natural size.
2. Part of an ambulacrum and interradium near the ambitus: magnified.
3. Part of an interradial area near the actinostome: magnified.
4. Side view: natural size.

Remarks. This species is interesting as presenting a link between the Diadematidæ and Echinidæ (Triplechinidæ). The structure of the ambulacra is essentially that of the former group, whilst the tuberculation and general facies is very suggestive of some of the fossil forms of *Psammechinus*. Although the specimen under notice accords closely with the generic formula of *Echinodiadema*; it differs greatly both in the form of the test and in the character of the tuberculation, and differs altogether in the presence of the *Salmacis*-like slits or grooves in the sutures of the interradial plates. This assemblage of characters readily distinguishes our form, and at the same time debars its admission to any known genus. It is to be hoped that further material will be forthcoming to enable a more complete diagnosis to be drawn up.

Subfamily ECHINIDÆ.

Section POLYPORI.

A fragment of a large regular Echinid of the Polypore type, with a stout test, has nine interradial plates from the apex downwards preserved; a corresponding space of an ambulacrum exists, as well as part of another interradium.

Genus EURYPNEUSTES, gen. nov.

Test of large size, probably subconoid or subdepressed, not tumid.

Ambulacral areas very broad, rather narrower than the interambulacral opposite the tenth plate. Poriferous zones very wide, about one fifth of the breadth of the interambulacral area. Pores arranged in three vertical series; five or six poriferous plates comprised in each whole compound ambulacral plate; the pairs of pores borne on each are disposed in the zone according to the following order: two or three consecutive pairs of pores form a slightly oblique arc at the outer margin of the zone; the pair borne on the next more aboral poriferous plate stands in the middle of the zone; and the pairs borne on the succeeding two plates are placed in slightly oblique sequence on the inner margin of the zone. The outer vertical series thus consists of slightly oblique arcs of two or of three pairs; the median series, which is somewhat irregular, of single pairs, widely spaced in vertical sequence; and the inner vertical series of two pairs of pores, which stand to one another in oblique succession. A straight and regular, vertical line of primary tubercles stands at the extreme margin of the interporiferous area on either side; one primary is on each plate, the intermediate space being occupied by a number of very small widely spaced secondary tubercles and miliary granules.

Interambulacral areas with two continuous vertical series of primary tubercles similar to, and only slightly larger than, the ambulacral tubercles, placed nearer to the poriferous zone than the middle of the plate; near the ambitus a second and more outward tubercle is present. The inner portion of the plate is occupied by very small secondaries and miliaries.

In consequence of the wide and trilinearly arranged poriferous zones, this genus presents a closer superficial resemblance to *Hipponoë*, Gray (*Tripneustes*, Agassiz), than to any other of the Polypori. In structural detail, however, it is widely separate, and is readily distinguished from any of the known forms by the crenulate tubercles, the number and arrangement of the pores and poriferous plates, and the character of the ornamentation.

1. **Eurypneustes grandis**, sp. nov. Plate VIII, Figs. 4, 5.

The ambulacrum is very wide, but near the ambitus it has not quite the breadth of the interradium there. The poriferous zone is very wide, but it does not equal the interporiferous area in breadth at a slight distance from the apex. The poriferous zones are nearly on a level with the rest of the test, being very slightly depressed; they are narrow towards the apex, but they soon enlarge, and then remain at very much the same breadth. The series of pores are not crowded except near the apex, where there is a simple succession opposite the first interradial plate; lower down there is crowding, and some pores are out of the straight line. The third interradial plate (and three below it) has in relation to it two distinct series of pores, an outer and inner, and an indefinite middle series. There is thus a vertical series of pairs of pores on either side of the poriferous zone, and a more incomplete one, with intervals here and there, in the middle part of the zone. Really, at the ambitus, there are two vertical series of triple pairs, one pair often being in the middle of the zone. Near the ambitus there are usually six poriferous plates to each whole composite ambulacral plate; but on the upper portion of the area, and also here and there elsewhere, one of the poriferous plates is wanting, and the regular sequence of two sets of triple pairs is destroyed. The pores are large and nearly circular in outline, and the three and two pairs are close, in vertical succession; but there is some space between the series in all directions.

The ornamentation of the poriferous zone is scanty; there are a few small tubercles, with slightly crenulated processes, and they are placed in twos or threes obliquely between the succession of the central series of pores. Usually the tubercles are of three sizes, the smallest being nearest the inner row of pores. Many sharply pointed miliaries exist on the ridges between the pores, and are oblong or in linear series.

The miliaries in linear series are very small, and follow the lines of the junction of the poriferous plates.

The interporiferous zone is narrow towards the apex, and it soon widens, so that at the level of the tenth interradial plate it is nearly twice the width of the poriferous zone. The plates are double the number of those of the interradial area, and each one carries, near the poriferous zone, a primary tubercle, imperforate and crenulated. These tubercles are smaller than the primaries of the interradial area, and increase in size from above downwards. They are in vertical series, and are well apart; and the surface of the test between the tubercles is plain. The remainder of the plate has a few very small and faintly crenulated secondary tubercles on it, and a few miliaries. The number of these small tubercles increases towards the ambitus, and seven or eight are noticed on the largest plates.

The interradial area has the plates slightly convex from side to side, and the sutures very distinctly marked. One vertical row of large crenulated, imperforate tubercles is on the ambulacral side of the plate, and a second and slightly smaller row is commenced at the sixth plate from the apex. The tubercles have broad bosses arising from a very faintly marked scrobicule environed more or less distinctly by a few wide-apart miliaries. The boss is tumid, and the crenulation passes down the flanks; the mamelon is small. The number of the large tubercles in vertical series, in relation to that of the ambulacral series, is one half; and the interradial ones are at least one third larger than the others. As the vertical series passes downwards it is placed nearer the centre of the plate in order to permit the second series to come in. In the higher plates, from the fifth towards the poriferous zone, there are a few small, crenulate, imperforate tubercles; they are represented by large miliaries nearer the apex, and by larger tubercles lower down. Towards the median line of the interradial area no large tubercles exist, but there are several crenulate and imperforate ones about the size of the boss of the larger tubercles, and they are scattered without order.

Here and there are some small miliaries. Hence there is much median space, without any large tuberculation, on the upper part of the test.

The breadth of the largest interradial plate is $\frac{1}{3}$ inch, and the breadth of the ambulacrum at the same level is $\frac{7}{8}$ inch.

Locality. North by east of Petiáni, west of Kotri. Ranikot series. Survey-number G $\frac{280}{135}$.

Illustrations of the Species in Plate VIII.

Fig. 4. The specimen of ***Eurypneustes grandis***, Duncan and Sladen: natural size.
5. The tenth interradial plates and corresponding ambulacral plates: magnified 3 times.

A large portion of the test of one of the regular Echini is in the collection from the Ranikot series. The actinal surface of the test is partly preserved, but only a small portion of the peristome is visible; the ambitus is defective, and there are parts of the ambulacra and interradial series above it in a bad state of preservation. The apical system is absent. The general shape has been preserved.

The details of the test indicate that it belongs to a genus not hitherto noticed, and they are described with the hope that, on some future occasion, more perfect specimens may be found.

Genus ÆOLOPNEUSTES, gen. nov.

Test of large size, subcircular or subpentagonal in marginal contour, subdepressed and subconical abactinally. Sides tumid.

Ambulacra broad, narrower than the interradial areas. Poriferous zone wide, equal to or greater than half the breadth of the interporiferous area; both zones broadest just above the ambitus, and decrease gradually towards the peristome. The pores on the abactinal portion of the zone are arranged in almost horizontal arcs of five or six pairs, very regular and very closely placed; below the ambitus on the actinal surface the number of pairs of pores in each arc diminishes, the arc straightens, and the angle of obliquity decreases, by gradual stages, until close to the peristome the pairs of pores stand in almost straight and simple vertical series.

In the interporiferous areas on the actinal surface there is a straight vertical series of primary tubercles, crenulate and imperforate, placed on each margin, and here and there a companion tubercle of similar size placed on the inner part of the plate; ordinarily, however, this part of the plate is occupied only with a few small and widely spread miliaries. It is impossible to state accurately the disposition of the tubercles above the ambitus.

The plates of the interambulacral area are very broad and short; in the actinal portion there are two continuous vertical series of primary tubercles, placed rather nearer to the poriferous zone than the middle of their respective plate. Near the ambitus there may be one or even two similar tubercles on either side of the central primary, standing in a horizontal line, the number of tubercles decreasing towards the peristome.

The ornamentation of the abactinal portion of the area is undistinguishable; but it is probable that the inner half of the plate was occupied only by rather widely spaced miliary granulation. The primary tubercles of both areas are small and uniform in size.

Peristome small and more or less sunken, with narrow and deeply-indented mouth-slits.

1. ÆOLOPNEUSTES DE LORIOLI, sp. nov. Plate VIII, Figs. 6–9.

The test is thin, pentagonal in marginal outline, tumid at the ambitus, and slopes thence gradually to a narrow apex. The actinal surface is generally flat, but there is a slight convexity about it, and the moderately sized peristome is decidedly sunken.

The breadth of the test is nearly double the height; the ambulacra are slightly more prominent above the ambitus than the interradial areas, which have a strongly marked median depression; and the primary tubercles are small and equal throughout, few in number, imperforate and crenulate.

The pores are in simple series near the peristome, but increase in number in relation to the interradial plates, towards the ambitus, and on the upper part of the test, where they are in several series of arcs in a broad zone.

The apical system is wanting in the specimen.

The ambulacra are broad, more than one half the width of the interradial areas just above the ambitus, and then contract gradually towards the peristome. The poriferous zones are wide, being, above the ambitus, equal to or even more than half the breadth of the interporiferous area, narrowing greatly towards the peristome. The pores on the abactinal portion of the zone are arranged in almost horizontal arcs of five or six pairs, very regular and very closely placed. Just below the ambitus on the actinal surface the number of pores in each arc is six, and the angle of obliquity about 45°; rather nearer the peristome the number is reduced to five; and about midway between the ambitus and the peristome there are only four, and these are arranged in slightly oblique lines instead of arcs; the number is then reduced to three, and the obliquity becomes still less, until close to the peristome the pairs of pores stand in almost straight and simple vertical series. The pores are round, conjugate, close; and close above and below, the pairs being separated by a ridge with a very small tubercle upon it. The composition of the ambulacral plate is interesting. The lowest or most adoral of its poriferous plates usually extends the whole breadth of the ambulacral plate, as a band-like strip of uniform thickness; the next pair of pores is borne on the primary ambulacral plate; and the succeeding poriferous plates are small wedge-like plates for the reception of which the primary ambulacral plate has its aboral and outer margin scooped away, the aboralmost of these small plates not being more than one half the breadth of the ambulacral plate, the intermediate ones smaller still.

The ornamentation of the interporiferous zone is simple: there is a small primary tubercle on each plate, placed nearer the poriferous zone than the median sutural line from the actinostome to near, or midway to, the margin, where a second tubercle is seen on two or three plates. The tubercles are small, nearly equal, and crenulate, and their bases are flush with the test. A few very small tubercles, larger than miliaries, are scattered without much order on the plates near the margin, and are still nearer the peristome.

The interradial areas are occupied by numerous low and broad plates, larger than those of the ambulacra; the median suture is well developed, and the other sutures also, and they indicate some curving of the upper and lower margins of the plates. The tubercles are small on the plates, equal to, if not slightly larger than those of the ambulacra. On the actinal surface there is one primary tubercle on each plate near the peristome; a little further out there are two, and nearer the margin three, and finally four to a plate. There are two vertical rows, which reach to the peristome on each interradial area; and then further out there are rows corresponding with the increase in number of the tubercles. There are a few very small tubercles, and some miliaries slightly smaller on the plates, and they are sparsely placed in more or less concentric rows around the larger tubercles.

Above the margin the number of larger tubercles can be estimated in spite of the worn condition of the test, and two on each plate appears to be the number. The smaller tubercles are larger there than on the actinal surface, and surround the larger ones in a scrobicular circle, giving a granulated appearance.

The cuts for the branchiæ are well developed.

The length of the test is nearly $1\frac{2}{10}$ inch, and the breadth is $2\frac{2}{10}$ inch.

Locality. Ranikot series, north by east of Petiáni, west of Kotri. Survey-number G $\frac{289}{135}$.

Illustrations of the Species in Plate VIII.

Fig. 6. The outline of the test: natural size.
7. The actinal surface: natural size.
8. A part of the actinal surface: magnified.
9. The cuts and the ambulacrum near the peristome.

Spines of Cidaridæ. Plates X. & XI.

Numerous spines of species of the genera *Cidaris*, *Phyllacanthus* (*Rhabdocidaris*), and *Porocidaris* are in the collection of Echinoidea from the Ranikot series of Sind.

SPINES OF SPECIES OF CIDARIS.

In Plate X. the figures 9 and 10 represent a long tapering spine with a slightly compressed outline, a plain surface for a short distance above the projecting ring above the base of the shaft, and longitudinal rows of small, close, bluntly serrate knobs along the shaft reaching from the plain surface to the tip.

A larger and more coarsely ornamented spine, with incisions on the ring around the hollow for the tubercle, is drawn at figures 11 & 12.

A thin, small, and almost plain spine with the milled ring slightly crenulate, on one side, is drawn on figures 13 & 14.

The locality whence these spines were derived was north by east of Petiáni, west of Kotri, in the Ranikot series. Survey-number G $\frac{280}{135}$.

The broader, stouter, more fusiform, and more roughly granular and spinulose spines, with slightly triangular and compressed sections, figured on Plate XI. figs. 1–11, are probably those of species of *Cidaris*.

Locality. Hills east of Lynyan, Ranikot series. Survey-number G $\frac{280}{136}$.

A *Porocidaris* spine of great interest is figured on Plate XI. Figure 12. The spine fractured, natural size, and its section. Figure 13. The same, magnified.

This spine is greatly compressed above the cylindrical base, which has a crenulate ring below the shaft, and also a crenulate ring around the cavity for the tubercle.

The shaft has a broad central part, from the sides of which numerous stout processes project obliquely upwards. The front of the flattened shaft has a longitudinally striated ridge; and the back is slightly convex and striated. The raised striæ pass off into the lateral processes.

Locality. Makli Hill scarp, near Tatta, Ranikot series. Survey-number G $\frac{284}{168}$.

Numerous large, much flattened, broad spines, with small crenulate rings, belong to the genus *Phyllacanthus* (*Rhabdocidaris*, Desor). The flat surfaces are ornamented with numerous blunt serrations; and these are largest at the sides, from which some project considerably. Plate XI. figs. 14–23.

Locality. Hills east of Lynyan, Ranikot series. Survey-number G $\frac{280}{137}$.

Order **ECHINOIDEA EXOCYCLICA.**

Suborder GNATHOSTOMATA.

Family CONOCLYPEIDÆ.

Genus CONOCLYPEUS, *Agassiz*, 1840 (amended).

Large Urchins, more or less oval or elliptical in marginal outline, conical, vaulted swollen or subconical above, rather flat actinally, and with a thick test. Apical system button-shaped and projecting; ocular plates very small. Ambulacra very long, straight, not tending to close; poriferous zones broad, conjugate; grooves well developed; interporiferous zone large. Peristome central, with well developed tumid bourrelets, and without a phyllode. Jaws exist, and auricles also. Periproct inframarginal or marginal, oval and longitudinal. Ornamentation small, very equal, of sunken scrobicules surrounding small tubercles, with a mamelon which is perforate and crenulate, and separated by a raised surface minutely granular.

1. CONOCLYPEUS SINDENSIS, sp. nov. Plate XII, Figs. 1–4.

The test is very thick, elliptical in marginal outline, subconical, broader than high, longer than broad, more tumid anteriorly than posteriorly (above the swollen ambitus), and sloping more suddenly anteriorly than posteriorly. The transverse section in a line with the apical system, which is excentric in front, is nearly hemispherical above. In the longitudinal section, the posterior slope from the apical system is at first rather sharply impressed, then curved outward somewhat tumidly at about two thirds the distance from the apex to the posterior extremity, and thence slopes down rather rapidly to the margin. The actinal surface is slightly tumid, and slopes to the margin and to the central peristome. Apical system defective, but was small.

The ambulacra are long and unequal. The odd and the anterior pair are straight; and the posterior pair, which are the longest, are gracefully curved, being bowed out laterally at their upper third conformably with the incurved or impressed portion of the odd interradium. They do not come very close to the margin, and are widely open at the extremity.

The poriferous zones are broad; the pairs of pores are numerous, the grooves between them well pronounced, and the raised intermediate ridges have one row of well-developed granules. In the anterior odd ambulacrum the poriferous zone is broader than the interporiferous area, except in the actinal third, where this last region is slightly the broadest. But in the posterior ambulacra, at the lower end of the upper third the interporiferous zone is equal in breadth to one of the poriferous zones. The inner pore is larger than the outer.

At the actinal termination of the ambulacra, and above the margin, the poriferous zones suddenly diminish in breadth, and the direction of the pores becomes oblique, and that of the grooves also; so that whilst the direction of the inner pores is nearly in the line of the series, that of the outer set describes about one quarter of a circle. A single row of pores is continued from each zone over the ambitus to the peristome, where the direction becomes slightly irregular and alternate; but there is no doubling there, nor is there a true phyllode. The interambulacra are swollen and somewhat boldly convex close to the apex; and they are more rounded and tumid midway to the ambitus.

The peristome is central, large, deep, transversely elongate; and the projecting, rounded, and bluntly pointed bourrelets have grooves between them for the gutter-shaped ends of the ambulacra.

The ornamentation is slightly largest actinally, and it decreases towards the ambitus. It is subequal and small on the apical part of the test, and everywhere consists of a raised interscrobicular granular part and sunken scrobicules with small tubercles consisting of a boss and small mamelon, which are not higher than the ordinary level of the test. Traces of crenulation are seen here and there; and the minute mamelon is perforate.

The periproct is inframarginal and elongate longitudinally, and it transgresses slightly on the margin, which is less tumid posteriorly.

Height of the test at the apex $2\frac{1}{10}$ inches, breadth 4 inches, length $4\frac{6}{10}$ inches.

Locality. North-east of Petiáni, west of Kotri. Ranikot series. Survey-number G $\frac{280}{135}$.

Illustrations of the Species in Plate XII.

Fig. 1. The actinal surface of the test: natural size.
2. An end of an ambulacrum: slightly magnified.
3. The ornamentation: magnified.
4. Part of an ambulacrum, high up: magnified.

2. CONOCLYPEUS ?, sp. Plate XII, Figs. 5, 6.

There is a specimen from the hills east of Lynyan, from the brown Ranikot limestone, which is so much worn that its specific diagnosis is not possible, and the generic is also doubtful.

The marginal outline is oval and broadest posteriorly; and the periproct is oval, pointed in front, longitudinal, and transgresses on the margin. The ambitus is tumid, and the abactinal surface is conical, the height being less than the breadth. The ambulacra come rather close to the margin, are widely open; and the poriferous zones are not very broad, and end in a point. The apex appears to have been central and the ornamentation small.

Probably it is a species of *Conoclypeus*; but the actinal surface is not visible.

Height of specimen $2\frac{1}{10}$ inches, breadth $3\frac{7}{10}$ inches, length $4\frac{3}{10}$ inches.

Survey-number G $\frac{280}{127}$.

Illustrations of the Specimen in Plate XII.

Fig. 5. Side view: natural size.
6. The periproct: natural size.

3. Conoclypeus declivis, sp. nov. Plate XII, Fig. 7.

Another specimen, probably of a species of *Conoclypeus*, is much broken and covered with brown limestone. It is oval, but is broadest in front and narrower, decidedly, behind; the margin is sharp, and the test slopes up to the apex, which is slightly excentric and in front not with a convex tumidity, but with here and there concave surfaces, becoming convex close to the apex. The ambulacra are unequal, the posterior being the longest, and they come down rather close to the margin; they are widely open, and the interporiferous zone is broader than a poriferous, nearly throughout. The poriferous zones are not very wide, end in a point, and the ridges between the conjugate pores are multigranular. The ornamentation of the interporiferous zone is of numerous sunken scrobicules, with intermediate granulation, and the bosses are small and with small mamelons. The interambulacra differ in size on account of the comparative closeness of the anterior and the antero-lateral ambulacra, and their shape gives a pinched-up appearance to the apical part of the test. The actinal part is invisible. The ornamentation is larger and scantier than in the forms already noticed.

Locality. East of Lynyan, Ranikot group. Survey-number G $\frac{289}{127}$.

Illustration of the Species in Plate XII.

Fig. 7. The test: natural size.

Suborder ATELOSTOMATA.

Family CASSIDULIDÆ.

Subfamily ECHINOLAMPINÆ.

Genus PHYLLOCLYPEUS.

Phylloclypeus, *de Loriol*, 1881, *Monographie des Echinides contenus dans les couches Nummulitiques de l'Egypte*, p. 79.

In true species of *Conoclypeus* the bourrelets around a more or less circular peristome are very large and equal, and the phyllodes have neither intercalated plates nor doubling of the ambulacral pores. In *Phylloclypeus* the bourrelets are not very large, are unequal, and surround a more or less pentagonal peristome. The phyllodes have intercalated plates and double pores, so that the floscelle is well developed. Some species of *Echinolampas* only differ from *Phylloclypeus* by having unequal poriferous zones; and it is advisable either to place *Phylloclypeus* as a subgenus of *Echinolampas*, or as a genus of Echinolampinæ as a subfamily. Certainly *Phylloclypeus* has no jaws.

1. ? **Phylloclypeus**, sp. Plate XII, Fig. 8.

A very fragmentary specimen of a large Echinoid is from the gypseous shales from the hills east of Lynyan in the Ranikot series.

The marginal outline is oval and broadest in front, the margins are slightly tumid, and the upper part is rather low and conical, the sides being convex. The apex is nearly central. The remnants of the ambulacra show that they were widely open, the poriferous zones being moderately broad, ending in a point close to the margin. The ridges, between the conjugate pores, are coarsely granular (one row), and the poriferous zone is narrower than the interporiferous area.

The most interesting part of the test is around the peristome, where a phyllode is preserved. The pores are evidently doubled in several instances, and the bourrelets do not appear to have been large.

There is then some doubt about this specimen belonging to the Conoclypeidæ, and we are disposed to place it with de Loriol's genus *Phylloclypeus*.

Height of specimen 2 inches; breadth $3\frac{8}{10}$ inches; length $4\frac{1}{2}$ inches.

Survey-number G $\frac{280}{120}$.

Illustration of the Species in Plate XII.

Fig. 8. The phyllode: magnified.

Genus PLESIOLAMPAS.

Plesiolampas, *Duncan & Sladen, Foss. Echin. of Sind, Pal. Indica*, series xiv. p. 9 (1882).

1. **Plesiolampas placenta**, sp. nov. Plate XIII, Figs. 4–9, and Plate XIV, Fig. 1.

The test is considerably depressed, slightly longer than broad, with a squarely oval marginal outline. Abactinally the slope from the, slightly eccentric in front, apical system is not quite so decided anteriorly as posteriorly; the margins are tumid, and in front more so than behind, where there is no rostration. Actinally the peristome is deeply seated in a concavity and is slightly in front of the centre, and the test is swollen around it to the margins, but less so posteriorly. The periproct is entirely inframarginal, reaches close to the edge, and is elongate oval.

The apical system is small and compact, the madreporic body is central and minutely granular on the surface. There are four generative pores, and the front pair are closer together than the hind ones. The ocular plates and pores are small.

The ambulacra are subequal, the posterior being the longest, rather wide, slightly petaloid, widely open, and extend to a short distance from the margin. The interporiferous zones are broad, slightly raised, and are widest about midway, and the poriferous zones of each ambulacrum are equal; the pairs of pores are numerous, oblique, conjugate, the outer pore being elongate and the inner subcircular, and the costal ridges have a row of minute granules on them.

Beyond the petaloid portion the ambulacra expand over the margin and contract close to the peristome. A single series of pores is continued as the prolongation of a poriferous zone, and the pores are close and numerous at the margin and as far as the peristome, the plates being broad but low. At the peristome the ambulacra narrow inwards, and have no doubling of the pores, but a slight departure from the serial lines, and within the peristome there are two pores close together. The ornamentation of the interporiferous zones is of sparsely distributed sunken scrobicules with a small boss, the intermediate parts being minutely granular. This ornamentation is closer at the margin and larger actinally, and it becomes scantier at the low gutter-shaped area of the ambulacra between the rudimentary bulging bourrelets. There is no true phyllode. In one specimen there is an appearance of a double row of pores, but the inner rows of pores do not penetrate, are more or less aborted, and each is overarched by a prominence developed on the next aboral plate; they appear to be depressions for sphæridia (Plate XIV. fig. 1).

The interradial areas are narrow at the apex; and the ornamentation of the abactinal part is of the same character as that of the interporiferous zones, but is scantier; and the granulation is more distinct, and it is closest and smallest at the margin, and largest and scantiest actinally.

The peristomial continuations of the interambulacra are slightly tumid, pass upwards between the ambulacra there, and are covered with a minute crowded ornamentation of small bosses; they constitute rudimentary bourrelets. The peristome is transversely elongated, open, pentagonal, and the bounding lines are convex and tumid inwards. Posteriorly, from the peristome to the periproct, is a median line of crowded minute granules, a few sunken scrobicules and bosses being along it here and there. The periproct is long, but distant from the peristome by more than its own length, is close to the margin, is broadest posteriorly, and is surrounded by a crowded ornamentation.

There is some variation in the shape of the specimens of this species, and it mainly relates to the position of the greatest breadth.

Height of specimen.	Breadth.	Length.	
$\frac{7}{10}$ inch.	$2\frac{1}{10}$ inch.	$2\frac{3}{10}$ inch.	
$\frac{6}{10}$ "	$1\frac{9}{10}$ "	$2\frac{1}{10}$ "	(Fig. 4).
$\frac{5}{10}$ "	$1\frac{7}{10}$ "	$1\frac{9}{10}$ "	(Fig. 5).
$\frac{5}{10}$ "	$1\frac{6}{10}$ "	$1\frac{8}{10}$ "	

Localities. Ranikot series, Jhirak, north-east of Petiáni, west of Kotri. Survey-numbers G $\frac{280}{1246}$, G $\frac{180}{135}$, G $\frac{226}{164}$.

Illustrations of the Species in Plates XIII & XIV.

Plate XIII.

Fig. 4. The test, from below.

Fig. 5. Another specimen; the test, from above.
6. Part of an ambulacrum: magnified.
7. The peristome: magnified.
8. The peristome: more highly magnified.
9. The longitudinal outline of the test.

Plate XIV.

Fig. 1. The rudimentary phyllode: magnified.

2. **Plesiolampas prælonga**, sp. nov. Plate XIV, Figs. 2, 3.

The test is elongate, the length in proportion to the breadth as 7 : 5, subdepressed and convex above, very tumid at the sides and in front, subrostrate posteriorly. Marginal contour elliptical, widest posteriorly opposite the extremities of the posterior petals, and then contracting somewhat rapidly to the posterior point; anterior to the widest part the outline is almost paraboloid. Actinal surface very tumid, with the peristome deeply impressed and the tumidity of the test slightly less in the posterior median line than elsewhere. The longitudinal profile shows the abactinal surface of the test to be very level, passing down with rather a rapid but well-rounded curve along the posterior rostration. The transverse profile presents rather a flatly convex outline, tumid at the sides, and bending round onto the actinal surface with an uninterrupted curve.

The apical system is small and excentric in front, its distance from the anterior extremity being little more than one third of the length of the test. There are four generative pores, the posterior pair larger and slightly wider apart than the anterior pair, and with two rather conspicuous small tubercles, similar to those which ornament the test, standing in a line drawn between the posterior pores. The madreporic body occupies the central space, and is prominently convex.

Ambulacra small, distinctly petaloid, converging towards their outward extremities; the antero-lateral petals terminating at a distance from the margin equal to one third of the length of the petal, whilst the posterior pair terminate at fully their own length distance from the margin. The petals of the paired ambulacra are of equal width, but the posterior pair are slightly longer than the anterior. The posterior poriferous zone of the antero-lateral ambulacra is somewhat longer by 2 or 3 pairs of pores, and more curved than the anterior zone; in the posterior petals, the curvature of the zones is equal, and their length does not differ by more than one pair of pores. The odd ambulacrum is covered by matrix. The anterior pair form a wide angle with one another, and the posterior pair a much smaller one.

The poriferous zones are narrow and slightly broadest at the middle of the zone, their width here, however, being less than one half the breadth of the interporiferous area. The inner pores are round, and the outer slightly elongate transversely; and they are united by a faint conjunctive furrow, the costal ridges that separate the pairs of pores being ornamented with a single line of minute uniform granules, five or six in number at the broadest part of the zone. In the antero-lateral ambulacra there are 29 or 30 pairs of pores in the anterior zone, and 32 in the posterior; and there are 38 or 39 pairs of pores in the zones of the postero-lateral ambulacra. The extrapetalous continuation of the zones consists of single pores, rather widely spaced, in consequence of the height of the extrapetalous ambulacral plates. Close to the peristome the pores are nearer together, and there is some irregularity in their serial arrangement, and two or three supplementary pores are present, thus forming a very indistinct and rudimentary phyllode. The interporiferous areas are flush with the surface of the test, but appear very faintly convex in consequence of the slight depression of the poriferous zones. The postero-lateral interradial areas are slightly prominent close to the apical disk.

The ornamentation of the interradial areas and that of the poriferous zones are similar, and consist of very small tubercles equidistantly spaced, and sunken in deep scrobicules, the intermediate space being granular and with a tendency to become confluent immediately round the scrobicule, the intermediate granules remaining more distinct. On the abactinal portion of the test the intermediate granular spaces are usually greater than the breadth of the scrobicules. In the interporiferous areas the tubercles are slightly smaller and more crowded, and also just below the ambitus. On the actinal surface the tubercles are larger than elsewhere, the scrobicules wider, and the intermediate space is reduced to seldom more than a single granular ring, and which becomes more or less confluent. There is an indistinctly defined, subconfluently granular, median band, devoid of tubercles, extending between the peristome and the periproct.

The peristome is large, slightly excentric in front, and more central than the apical system, transversely elliptical, the breadth being $\frac{1}{3}$ inch, and the shorter diameter $\frac{1}{5}$ inch, with the lateral apses acutely angular. The peristomial wall is closely granular, and there is no development of bourrelets. The terminal portions of the ambulacral areas which form the incipient phyllodes are very faintly sunken.

The periproct is large, elliptical, placed longitudinally and inframarginal, sloping up slightly from the actinal surface, and overarched by the posterior rostration of the odd interradium. The length is $\frac{5}{20}$ inch, and the breadth $\frac{3}{20}$ inch.

Dimensions. Length of the specimen $1\frac{4}{10}$ inch, breadth 1 inch, height $\frac{11}{20}$ inch.

Distance of apical system from posterior edge $\frac{3}{10}$ inch.

Locality. East of Kandaira in the Vero plain, Ranikot series. Survey-number G $\frac{226}{155}$.

Remarks. This is more nearly related to *Plesiolampas elongata*, Duncan and Sladen*, than to any other member of the genus. It is distinguished from that orm by the more elongate and anteriorly more contracted test, by its more level abactinal surface and less gibbous posterior rostration, by its much wider, more petaloid, more highly developed, and differently proportioned ambulacra, by its more actinally placed periproct, and finally by its more widely spaced tuberculation. Thgouh thus well marked specifically, there is no doubt of this form being the representative of the Infra-Trap species in the Ranikot strata.

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* Part i. page 10.

Illustrations of the Species in Plate XIII.

Fig. 2. Actinal aspect of the test: natural size.
  3. Apical disk and part of the surrounding portion of the abactinal surface: magnified.
  Also a portion of the poriferous zone: more highly magnified.

Numerous specimens of a *Plesiolampas* from $\frac{3}{10}$ inch to nearly 1⅓ inch in length were found at a spot north by east of Petiáni, west of Kotri; on hills east of Lynyan, from the brown limestone and gypseous shales, in the Ranikot series.

Every stage of growth from a minute globular and slightly elongate form to a depressed ovoid (the adult shape) is represented in the series of specimens; and in all there is a large, open, transverse, elliptical peristome, a large ovoid periproct placed longitudinally, marginally, or submarginally, and short, open ambulacra placed eccentrically in front of the centre. The floscelle is feebly developed. The adult form may be taken as the type.

3. PLESIOLAMPAS OVALIS, sp. nov. Plate XIV, Figs. 4–18.

The test is moderately thick in substance; and its marginal outline is ovoid, with a slight enlargement behind the centre on either side, and a slight blunt point where it is narrowest behind.

Above, the shape is slightly convex, and rather flat at the vertex and median line; the margins are well rounded, especially anteriorly. The highest point is rather behind the centre of the upper part, but the slope is very gradual from it. Beneath, the surface is slightly concave, especially near the peristome.

The apical system is eccentric and in front of the centre; the generative pores are four in number, and surround a well-developed, convex, madreporic body. The ambulacra are subpetaloid, are open at the end, and show but a slight disposition to close; and the perfect poriferous zones end far from the margin. The anterior ambulacrum is the shortest and usually the narrowest; it is widely open anteriorly, has a narrow interporiferous zone, and equally developed poriferous zones. The pores, as in the zones of all the ambulacra, are conjugate; the outer series are the largest, and are round in worn specimens, rather elongate when well preserved. The inner are smaller and rounder. This ambulacrum, like the others, is very slightly raised above the level of the test, and its zones are of equal length, or one may have one pair of pores more than the other.

The ocular pore, as is the case in the other ambulacra, is small, and the first three or four pairs of pores are exceedingly small and close, so that a small space exists around the apical disk, where, in all the ambulacra, there appears a defective poriferous development. The pores become fully developed in all the ambulacra in about one quarter the length of the zones.

The antero-lateral ambulacra form the sides of a very open angle; they are more petaloid than the others, and their interporiferous zones are the largest. They are shorter than the posterior ambulaca, which are open and form an acute angle, and terminate far from the end of the test.

A line of single pores passes from the *inner* set of each poriferous zone over the margin, including a space which extends close beyond the end of the petals and contracts towards the peristome, where there is a slight flaring and apparent doubling of a few pores. The poriferous zones are rarely unequal, and then only in a slight degree.

The peristome is less excentric than the apical system, is large, open, transverse, elliptical, with the front rather sharply curved, and broadest from side to side. The interambulacral portions of the mouth are nearly vertical and are profusely granular, and there is a faint broad bourrelet-ridge. The phyllodes are small, but there is a doubling of pores, and two pores are seen within the peristome.

A band of miliaries with traces of zigzag lines, more or less worn, exist between the peristome and the periproct, which in large specimens is inframarginal or slightly obliquely placed in the margin itself. It is large, ovoid, widely open, and the length is longitudinal. It is close to or at the margin, and has a point or rudimentary rostrum overhanging it above.

The ornamentation of the upper part of the test is of small tubercles with distinct scrobicules; and the raised surface between them is minutely granular, with microscopic miliaries. The same ornamentation is on the interporiferous zones. The interambulacra are slightly raised between the petals and close to the apical system. The tubercles are larger actinally and less crowded there.

Length of largest specimens rather more than $1\frac{4}{10}$ inch, breadth $1\frac{1}{10}$ inch, height $\frac{6}{10}$ inch.

Locality. North by east of Petiáni, west of Kotri. Survey-number G $\frac{250}{124}$. Jhirak, and hills east of Lynyan. Survey-number G $\frac{230}{126}$.

Other specimens:—

Length $1\frac{3}{10}$ inch, breadth 1 inch, height $\frac{5}{10}$ inch. In specimens of this length the posterior projection is very evident, and the periproct is oblique on the margin, ovoid, large, open, and longitudinal in its great axial direction.

Smaller specimens $1\frac{1}{10}$ inch in length, are $\frac{9}{10}$ inch broad, and rather over $\frac{4}{10}$ inch in height.

Locality. East of Kandaira, on the Vero plain. Survey-number G $\frac{220}{133}$.

Another, 1 inch long, is $\frac{8}{10}$ inch broad and nearly $\frac{5}{10}$ inch high.

Locality. Hills east of Lynyan. Survey-number G $\frac{250}{135}$.

Its periproct is inframarginal and very slightly transgressive.

A smaller, $\frac{9}{10}$ inch long, is $\frac{7}{10}$ inch broad and $\frac{4}{10}$ inch high. A second, $\frac{8}{10}$ inch long and $\frac{6}{10}$ inch broad, is $\frac{4}{10}$ inch high, and the mouth is more central, and the huge longitudinal periproct is oblique on the margin and rostrated.

One, $\frac{7}{10}$ inch long, rather over $\frac{5}{10}$ inch broad, is just under $\frac{4}{10}$ inch in height.

Other measurements are:—

Length $\frac{6}{10}$, breadth $\frac{5}{10}$, height $\frac{3}{10}$ inch.
„ $\frac{5}{10}$, „ $\frac{4}{10}$, „ $\frac{3}{10}$ „
„ $\frac{4}{10}$, „ $\frac{3}{10}$, „ $\frac{5}{20}$ „
„ $\frac{3}{10}$, „ $\frac{5}{20}$, „ $\frac{2}{10}$ „

Remarks. The worn specimens of the larger types give a fallacious idea of the poriferous zones; for when well preserved they are traversed by a succession of bars between the pairs of pores, and they are covered with a row of miliaries. The linear nature of the pores is then shown and their conjugate nature.

The petals never reach the margin; and their inequality is very slight, and never amounts to that of the typical Echinolampidæ described by MM. d'Archiac and Haime. The miliary median space inferiorly and the shape and position of the periproct are worthy of notice.

Premature Forms. The examination of the young forms gives some very interesting results.

The shape of the young forms is higher, more tumid, convex at the top, elongate; and the periproct is large and obliquely placed on the posterior margin, and invading the under surface also. It is longitudinal and oval. The peristome is large and subcentral.

The poriferous zones in the very small forms are not developed near the ocular pores, but they are further out. They are sensibly unequal, short, and the whole rosette is anterior and small. The deficiency of pores in the anterior ambulacrum is remarkable in some specimens.

The next group, in point of size, show increasing elongation of the test, and the unequal condition of the poriferous zone is palpable. All this is seen in specimens $\frac{1}{8}$ inch in length, and in others in a less degree up to $\frac{3}{4}$ inch. The test is then flatter, but the large periproct and peristome are rather close together, the former transgressing on the lower surface. The unequal pore-zones are not so definite. In some there is a slight difference in the size of the poriferous zones in the same petal.

Illustrations of the Species in Plate XIV.

Fig. 4. The actinal aspect: natural size.
5. Portion of the median granular band and periproct: magnified.
6. Outline of the longitudinal profile of the test.
7. Abactinal view of another specimen.
8. Apical disk and portion of abactinal surface of another specimen: magnified.
9. Abactinal aspect of a young specimen: natural size.
10. Actinal aspect of the same: natural size.
11. Abactinal aspect of a young specimen: natural size.
12. Apical disk of the same specimen: magnified.
13. Longitudinal outline of the same specimen: natural size.
14. Actinal aspect of very young specimen: natural size.
15. Longitudinal aspect of the same.
16. Abactinal view of the same test: natural size.
17. Peristome of a specimen one inch in length: magnified.
18. Apical disk and surrounding structure of the same specimen (Fig. 14): magnified.

4. **Plesiolampas rostrata**, sp. nov. Plate XIII, Figs. 1–3.

The test is moderately depressed, slightly longer than broad, broadly elliptical in marginal outline, broadest close behind the eccentric-in-front apical system, rather narrower in front than posteriorly, and having a slightly rounded-off posterior projection, with a faint depression on either side of it, just posterior to the postero-lateral ambulacra. The highest point of the test is at the apical system; and the surface slopes thence to the margin, which is slightly tumid, and least so where the test is pinched in posteriorly. Actinally the surface of the test is faintly convex; but the peristome is deeply seated. The periproct is long, oval, and inframarginal, and it does not touch the margin. The apical system has a large madreporic body. The ambulacra are long, widely open; and there is only the slightest tendency to a petaloid form in the postero-lateral; the anterior is the shortest, and the postero-lateral are the longest. The interporiferous zones are broad, and the ornamentation is irregular, there being spaces where the granulation predominates over the tubercles and scrobicules.

Height of specimen rather more than $\frac{8}{10}$ inch, length 3 inches, breadth $2\frac{7}{10}$ inches.

Locality. Ranikot series, north by east of Petiáni, west of Kotri. Survey-number G $\frac{280}{135}$.

Illustrations of the Species in Plate XIII.

Fig. 1. The test, from above.
2. The test, side view.
3. The periproct.

5. **Plesiolampas polygonalis**, sp. nov. Plate XIII, Figs. 10, 11.

The test is polygonal in outline, moderately tumid at the ambitus, tumid abactinally, highest behind, very concave actinally. The greatest breadth is at the blunt angular projection over the antero-lateral ambulacra; and the test is narrowed rapidly behind those regions, and less so in front; it is rather truncated behind, and has a wide angle in front. The apical system is slightly eccentric in front, and is over the deeply seated widely transverse peristome. The periproct is inframarginal, elongated longitudinally, and narrow. The ambulacra are narrow, long, open, and very faintly petaloid.

Length $1\frac{7}{10}$ inch, breadth $1\frac{5}{10}$ inch, height $\frac{6}{10}$ inch.

Locality. North-east of Petiáni, west of Kotri, Ranikot series. Survey-number G $\frac{280}{135}$.

Illustrations of the Species in Plate XIII.

Fig. 10. The test, from above.
11. The test, longitudinal outline.

Genus EOLAMPAS, gen. nov.

Test small, tumid, ovoid, subdepressed; the greatest height corresponding with the apical disk, and very eccentric in front; the anterior slope rapid and precipitous, the posterior subrostrate towards the extremity.

Ambulacra small, short, petaloid, subequal; the odd anterior ambulacrum aborted. Poriferous zones subequal, pores conjugate.

Apical disk eccentric in front, small; generative pores four, and madreporiform body central.

Peristome transversely oval, subcentral or very slightly eccentric in front, with perpendicular wall reaching upward into the body-cavity. No bourrelets. Phyllodes very faintly developed. Buccal pores opening into the peristomial margin, with a small granule-like prominence over each standing at the extreme edge of the peristomial ring.

Periproct marginal, transverse (?).

Tuberculation small, homogeneous, in sunken scrobicules; intermediate space subgranular and confluent.

This genus is closely related to *Echinolampas*; indeed the test might at first sight be regarded as that of a young or abnormal form; but the small and subequal ambulacral petals, the aborted odd ambulacrum, the very anterior apical disk, together with the form of the test and the character of the peristome appear to demand a generic separation. Furthermore, no true *Echinolampas* has hitherto been found in the Ranikot series, whilst the form under notice is recorded from three localities.

Eolampas also occurs in the Khirthar series; and although these beds are very rich in *Echinolampas*, we are unable to refer the form (apart from its special characteristics) to the young of any species there present.

1. Eolampas antecursor, sp. nov. Plate XVII, Figs. 11–15.

The test is tumid, highest in front, with a precipitous anterior portion and a more gradually sloping and curved posterior part, the top of the test being on a very gradual backward slope. It is longer than it is broad, and broader than high. The transverse outline is nearly hemispherical; and the marginal outline is oval or elliptical, the greatest breadth being about central. The margins are tumid, the actinal surface is slightly hollowed out or concave, there is barely a keel posteriorly, and the anterior and lateral parts of the test overhang the base. The apical system is very eccentric in front, and the peristome is subcentral; the periproct is just above the margin and is small. The apical system is small; there are four small generative plates and pores; and the madreporic body is small and central. The ambulacral rosette is small in relation to the size of the test; and the ambulacral petals end remotely from the margin, and the posterior pair more than their own length from the posterior end of the test.

The anterior ambulacrum has no double pores, but there is a series of broad grooves amongst the ornamentation of the test in their position; the grooves are more numerous than the pairs of pores of the other ambulacra, and no trace of a pore is to be seen in them. A worn test shows neither grooves nor pores in the region of the odd ambulacrum.

The antero-lateral ambulacra form a widely open angle, being nearly transverse in their position; they are petaloid, not closed, and they are slightly broader than the others. The anterior poriferous zone is straighter than the posterior; and the pairs are not very numerous, are oblique, conjugate, with well-marked intermediate ridges; and their pores are large, circular or slightly elongate in outline, and subequal in the pairs. The interporiferous zone is widest towards the half-distance from the apex. The postero-lateral ambulacra are narrower than those just described, and either slightly longer than or equal to them; and the width of the poriferous zones is less. They form an acute angle at the apex, and are nearly closed distally. The pores are oblique. A single row of wide-apart pores passes over the margins from each poriferous zone; and at the peristome the rows approach to form a rudimentary phyllode whose pores are at the sutures of the plates; and there is no doubling of them. The ornamentation of the petaloid areas is the same as that of the surrounding test, and consists of numerous small sunken scrobicules, with short and broad tubercles in them.

The interradial areas are largely developed abactinally. The anterior are marked by a larger ornamentation than elsewhere; and the posterior is rounded between the ambulacra and narrow, but it does not form a decided keel; it is slightly pinched in near the margin, on either side of the line leading down to the periproct.

The peristome is at the deepest point of the actinal concavity, large, widely open, deep, transverse, and elliptical in outline, the smallest angles being at the sides. A process composed of the inner parts of the plates around the peristome passes upwards like a short canal; and its surface is minutely granular. The ambulacra of the peristome are narrow; and the first two plates have each a pore on them, which penetrates the plate and looks into the canal just mentioned. The other plates are narrow, and gradually become broader towards the margin.

The edge of the peristome between the phyllodes is slightly raised, and in the natural position projects slightly downwards. The ornamentation of the actinal surface of the test is slightly larger than that of the upper part; and there is a small knob close to the peristome on either side of the ambulacra.

There is a faint groove in front of the peristome; and the anterior margin is slightly incised by it in young specimens. The periproct is supramarginal or marginal, small, and is slightly overhung by the faint keel.

Length of specimen (Figures 11 & 12) $\frac{8}{10}$ inch, breadth $\frac{7}{10}$ inch, height $\frac{5}{10}$; length of a second specimen $\frac{6}{10}$ inch, breadth $\frac{5}{10}$ inch, height $\frac{4}{10}$ inch; length of a third specimen $\frac{15}{30}$ inch, breadth $\frac{13}{30}$ inch, height $\frac{11}{30}$ inch.

Localities. 1. From hills east of Lynyan in gypseous shales, high horizon. Survey-number G $\frac{280}{120}$.—2. North-east of Band Vero, from the *Operculina* beds. Survey-number G $\frac{280}{130}$.—3. The same as No. 1. Survey-number G $\frac{280}{127}$. All are from the Ranikot series of strata.

Illustrations of the Species in Plate XVII.

Fig. 11. The side view: natural size.
12. From behind: natural size.
13. Outline of actinal surface: natural size.
14. The apical system and petals: magnified.
15. The peristome: magnified.

Subfamily ECHINANTHINÆ.

Genus ECHINANTHUS, *Breynius.*

1. **Echinanthus enormis**, sp. nov. Plate XVII, Figs. 5–10.

The test is tumid, irregularly hemispherical, higher in front than behind, longer than broad, and stands on a small base, which is overhung by the swollen margins. The marginal outline is elliptical and broadest centrally, rounded in front, and very faintly marked by a groove posteriorly in the median line. The test is faintly swollen and convex actinally. The highest point of the test is eccentric in front; thence it slopes rapidly, the anterior longitudinal section being nearly semicircular; behind the slope is gradual and longer to the slightly projecting edge above the periproct. From the periproct, which is rather high up, there is an oblique truncation, so that the test passes from the posterior margin upwards and backwards. On either side of the apex the slope is less convex, so that a conical appearance is given in section.

The apical system is very eccentric in front; and the disk corresponds with the highest point of the test; there are four generative pores; and the madreporic body is small and central.

The anterior odd ambulacrum is dwarfed and very short, it is open and narrow; the poriferous zones are short; and in different specimens there are from 8 to 15 pairs of pores in each zone, which are conjugate. It reaches but a short distance down the rapid anterior slope; and then the inner row of each poriferous zone is continued in single series, which gradually widen apart to the margin, over which they pass to the peristome.

The antero-lateral ambulacra are well developed, form a large angle, are petaloïd, moderately open, and have broad interporiferous zones. The poriferous zones are rather narrow; and the subcircular large pores are conjugate, with well-marked ridges between the pairs.

The postero-lateral ambulacra are the longest, form an acute angle, and reach to within their own length of the posterior truncation. Narrower than the antero-lateral pair, more lanceolate, and more open, they are broadest near their inner third.

The interambulacra are largely developed on account of the smallness of the abactinal rosette, and the posterior one is marked by a very faint rounded keel leading to the periproct. The ornamentation is of small tubercles in shallow sunken scrobicules, and it is rather close.

Actinally the test is slightly convex; and the peristome is small, excentric in front, pentagonal, longest transversely (in some specimens the longitudinal axis of the peristome is not quite in the median line). The floscelle is moderately developed; the bourrelets are slightly tumid and project downwards; and the phyllodes are open distally, are short, and have a few double pores.

The ornamentation of the actinal surface resembles that of the abactinal; and here and there minute granules encircle the scrobicules, and others are on the intermediate parts of the test.

The periproct is high up, oval in the longitudinal direction, and has a faint groove below it on the sloping truncation.

The length of the test of one specimen is $\frac{6}{10}$ inch, breadth $\frac{5}{10}$ inch, and height $\frac{5}{10}$ inch. A larger specimen is in length $\frac{7}{10}$ inch, breadth $\frac{6}{10}$ inch, and height $\frac{5}{10}$ inch.

Localities. From hills east of Lynyan, Ranikot series (Survey-number G $\frac{280}{128}$): and north-east of Band Vero in the same group (Survey-number G $\frac{280}{130}$).

Illustrations of the Species in Plate XVII.

Fig. 5. A large specimen, side view: natural size.
6. A smaller specimen (the type), side view: natural size.
7. The same, from behind: natural size.
8. The apical region: magnified.
9. The peristome: magnified.
10. Ornamentation: magnified.

Remarks. Although the shape of the test of this species is very abnormal for *Echinanthus*, we consider that the essential characters of its structure are naturally referable to that genus, of which, however, it will stand as a very extreme form. It is readily distinguishable from any of the species hitherto described.

Genus CASSIDULUS, *Lamarck*, 1801.

Test of small or moderate size, oblong, convex above, flat beneath, or slightly depressed along the median longitudinal line.

Apical system slightly eccentric in front.

Ambulacra short and very petaloid. Pores conjugate, the external series more elongate than the internal.

Peristome subpentagonal, more or less eccentric in front, surrounded with a well-developed floscelle.

Periproct oval, longitudinal, supero-marginal, placed at the commencement of a short groove which does not indent the margin.

Tubercles small and uniform on the abactinal surface, but much larger on the actinal surface, excepting along a median longitudinal band.

1. **Cassidulus ellipticus**, sp. nov. Plate XV, Figs. 7–10.

The test is long, depressed, elliptical in marginal outline, longer than broad, nearly twice as broad as high, slightly broadest behind the peristome, flat below, with a very slight downward projection of the posterior end, which is truncated for a short distance in the median line. The margin is rounded and tumid in front, and less so and more sharp at the sides and posteriorly. Above, the test is very regularly convex in transverse outline. The longitudinal outline is rather flat behind the slightly eccentric-in-front apical system; there is a faint keel, and then a sudden fall and a sharp slope to the margin. In front the slope is more gradual and faintly curved to the more rounded anterior margin. The posterior part of the test above, is flatter than the anterior.

The peristome is under the apical system, and is slightly in front of the centre. The periproct is supramarginal, in a deep groove, which slightly flattens out posteriorly, where it terminates at the truncated end of the test. It is narrow and longitudinal, nearly vertical, and under the overhanging test; and its position is considerably behind a line which would unite the extremities of the posterior petals.

The apical system is small; the four generative pores are distinct; and the madreporic body, which does not extend backwards to separate the posterior ocular plates, is well developed and central. The ambulacra are petaloid, and the antero-lateral and posterior are nearly closed; the anterior ambulacrum is the broadest, and the posterior are the largest. The ambulacra are broadest in their apical half, and the zones are well developed; but the posterior poriferous zone of the posterior ambulacra is slightly smaller, especially near the apex, than the anterior zone of the same ambulacrum. Otherwise the poriferous zones are well developed, and one of them is nearly as wide as the interporiferous zone is broad.

The poriferous zones are nearly flush with the test, and the numerous conjugate pores are separated by distinct costal elevations ornamented with a single row of granules. The inner pores are more or less circular in outline, and the outer are smaller and more elongate; and the direction of the conjugate grooves is oblique. The poriferous zones of each ambulacrum are equally bent. The interporiferous zones are very slightly raised, are ornamented with numerous tubercles standing in sunken scrobicules, and which are slightly smaller than those in the interambulacral spaces.

The ambulacra do not reach near the margin; and the end of the posterior is $\frac{6}{10}$ inch from the posterior end of the test, the periproct being $\frac{3}{10}$ inch from the same part. The interambulacra are well rounded off; but there is a faint keel between the posterior lateral, which reaches backwards to the periproct. The ornamentation of the interradials is small on the apical surface of the test, and gradually increases in size at the margin; it consists of small tubercles in sunken scrobicules, with the intermediate area or ridge covered with minute granules.

The peristome is slightly longest longitudinally, is large, pentagonal, and the floscelle is highly developed. The bourrelets are granular and swollen, with tubercles on the lowest projecting point; and the buccal pores are in nearly closed phyllodes, which are petaloid and broad. The reduplicate pores are numerous; and there are two sets of depressions for sphæridia along the interporiferous line.

The ornamentation of the actinal is much larger than that of the abactinal surface, and the tubercles are often placed on one side of their scrobicule and close to the intervening ridges. The large tubercles are seen along the lines of the ambulacra beyond the phyllode; and close to the edge of the test all the ornamentation becomes suddenly small. A cancellated and worm-eaten tract extends in the median line from the mouth to close to the truncated margin, and it is also seen in front of the peristome. It appears to be produced by confluence of granules.

The shallow groove of the periproct has a very small ornamentation, which merges into that of the sharp truncation.

Length of specimens $1\frac{5}{10}$ and $1\frac{3}{10}$ inch, breadth $1\frac{1}{20}$ and $\frac{9}{10}$ inch, height $\frac{5}{10}$ and $\frac{4}{10}$ inch.

Locality. In the Ranikot series, north by east of Petiáni, west of Kotri. Survey-numbers G $\frac{280}{135}$ and G $\frac{280}{135_a}$.

Illustrations of the Species in Plate XV.

Fig. 7. A specimen of the test, from above.
8. The transverse section.
9. The floscelle and ornamentation: magnified.
10. The ornamentation of part of an ambulacrum.

Genus RHYNCHOPYGUS, *D'Orbigny*, 1855.

Test of small or moderate size, depressed, elongate, convex above, concave beneath. Apical system subcentral or eccentric in front.

Ambulacra subpetaloid, almost straight.

Periproct supramarginal, transverse, surmounted by a more or less developed, subrostrate roof. Peristome pentagonal, subcentral, or only slightly excentric, with well-developed floscelle, the bourrelets being large and the phyllodes highly developed and ornamented. Tubercles much larger on the actinal surface than on the abactinal.

There is much to be said in favour of the classification of Alexander Agassiz, which places this group as a subgenus of the genus *Cassidulus.* We retain it as a genus provisionally; for our ideas of classification develop themselves as this great series of Echinoderms is gradually examined and described.

1. Rhynchopygus Calderi, *d'Archiac & Haime*, sp. Plate XV, Figs. 1–4.

Eurhodia Calderi, *d'Archiac & Haime, Descrip. Anim. foss. du groupe Numm. de l'Inde*, p. 352, pl. xxx. fig. 19.

A single example of a Cassidulid, which we refer to d'Archiac and Haime's species, is included in the collection of the Echinoidea of the Ranikot series. The specimen is large but badly preserved, and, from not being found in place, doubt exists as to the correctness of its being included in this series. It may have come in from a higher horizon—probably the Khirthar. We have compared this fossil with a series from that group, and find that the accordance both of the form of the test and also of the matrix is exact. Still, as the doubt exists, we mention the species here, and give a description of the imperfect specimen by which it is represented. A more complete detail of structure will be given when we treat of the fossils of the Khirthar group, which is probably the true horizon of the form.

The test is elongate, ovoid in marginal outline, moderately high, and roof-shaped above, rather sharply rounded in front, broader and rounded behind, except on either side of the median line, where it is truncated and slightly reenteringly curved. Actinally the test is slightly concave. The margin is tumid, but less so posteriorly; and there are projections on it—one at the posterior third, and another close to the truncation. The anterior part of the test of the ambitus is on a slightly higher level than the sides; and there is a corresponding upward slope, posteriorly, starting from the first projection on the margin. The apical part of the test is rather roof-shaped; and there is a rounded eminence passing from the interporiferous zone of the anterior ambulacrum, over the top of the test, backwards to the transverse slit-like process covering the periproct. The test slopes from this long keel, is flatter midway between it and the margin than at the ambitus, and slopes more gently anteriorly than towards the overhanging periproct-ridge.

The apical system is slightly in front of the centre of the upper part of the test; and the anterior odd ambulacrum is large, broad, very open anteriorly, and has broad poriferous zones. The line of the inner pores of the poriferous zones is nearly straight, and that of the outer pores a curve; the interporiferous zone is well developed and broader than one of the poriferous zones. The antero-lateral ambulacra are destroyed, except close to the outer end of one, which is not closed; but the poriferous zones are closer together than in the anterior odd ambulacrum. The posterior ambulacra do not reach to the line of the periproct-ridge; but they are too badly preserved to be described.

The periproct is transverse, is overhung by a projection of the keel, and it is in a broad groove very visible from above, which is slightly hollowed out, and merges by a convex edge into the truncated but slightly reentering margin. The highest part of the test is in rear of the centre, but the abactinal roof is very level.

On the actinal surface there is a larger ornamentation than on the abactinal, and there are traces of a pitted structure in the median line posteriorly.

Length of the specimen $1\frac{7}{10}$ inch, breadth $1\frac{3}{10}$, height $\frac{8}{10}$ inch.

Locality. There is some doubt whether this form came from the Ranikot series, and it may belong to the Khirthars above. Survey-number G $\frac{380}{135}$.

The list says north-east of Petiáni, west of Kotri (not found in place, probably Khirthar group).

Illustrations of the Species in Plate XV.

Fig. 1. The test, side view: natural size.
3. The test, from behind: natural size.
2. The odd ambulacrum, slightly pitted: magnified.
4. The surface of actinal median line: magnified.

2. Rhynchopygus pygmæus, sp. nov. Plate XV, Figs. 5, 6.

This species is much smaller than the last, but is of the same general shape except in the absence of the long even abactinal keel; the test is more convex in front from the ambitus to the apex than in the other form. The actinal surface is concave from side to side, and the truncation posteriorly barely exists.

The rosette is moderate in size; and the anterior odd ambulacrum is characterized by its open extremity, large interporiferous zone, straight inner line of pores, and the curved outer lines. The antero-lateral ambulacra are smaller than the others, and do not reach halfway to the margin. The posterior ambulacra are longer than these last, have a narrow interporiferous zone, have the posterior poriferous zone slightly smaller than its fellow, and they terminate more than halfway from the apical disk to the transverse process above the periproct. All the ambulacra are well open at their ends; and the straightness of the inner lines of pores is very characteristic. There is a rounded keel over and in front of the transverse oval periproct, which is in a broad shelving groove.

The floscelle of the peristome is highly developed; and the cribriform structure of the median line is evident, being bounded by a larger ornamentation than exists on the abactinal surface. The large ornamentation consists of tubercles in broad scrobicules, separated by ridges; several of the tubercles are on one side of the scrobicule.

Length of specimen $\frac{7}{10}$ inch, breadth $\frac{11}{20}$ inch, height not quite $\frac{1}{3}$ inch.

Locality. In the Ranikot series, north-east of Petiáni, west of Kotri. Survey-number G $\frac{280}{135}$.

Illustrations of the Species in Plate XV.

Fig. 5. The test, from above: natural size.
6. Part of the phyllode and pitted structure: magnified.

Genus EURHODIA.

Eurhodia, *d'Archiac & Haime, Animaux fossiles de l'Inde*, p. 214.

The superior petals are small, almost closed, and have unequal poriferous zones; the buccal petals are closed, subequal, and have their inner pores double. The peristome is surrounded by slight and unequal tuberosities; and the periproct is supramarginal, and opens into a slight depression; it is large, ovular, and elongated transversely.

This diagnosis was founded in order to separate *Eurhodia* from some other Cassidulids, and especially those of the genera *Pygorhynchus* and *Hardouinia*. It was the result of the study of specimens which were small and had the peristome incompletely shown or badly preserved. Two species were recorded, one *Eurhodia Morrisii*, which replaced *Pygorhynchus Morrisii*, d'Archiac, and *Eurhodia Calderi*, Haime.

The first of these is carefully described by d'Archiac and Haime in their 'Animaux Fossiles,' p. 214, but not from one good or a large series of good specimens. Hence the correct shape of the test and many specific points are not recorded, and their specific determination becomes almost generic in its value. Moreover the type of the distinguished authors was not full-grown by one third.

Some thirty-five specimens were collected in the Ranikot series; and as most of them are in good condition, many points of structural importance can be elucidated, and the specific characters slightly amended. But the generic attributes are not correctly given by MM. d'Archiac and Haime, and it is found that the diagnosis, although remarkably clear, is hardly positive enough, and yet too comparative, especially as it relates to two other genera from which this is distinguished.

Genus EURHODIA, *d'Archiac and Haime* (amended).

The test is large and stout; it is elongate, oval, and is truncated posteriorly, broad in front, depressed, rather flat, or slightly rounded above, slightly concave actinally and tumid at the ambitus. Apical system and rosette small, eccentric in front; petals small, unequal, open, especially that of the odd ambulacrum. Poriferous zones unequal in size. Peristome large, eccentric in front, very elongate longitudinally, pentagonal; floscelle highly developed; pitted structure in the median line of the test inferiorly.

Periproct elongate transversely, supramarginal, transverse, in a shallow broad groove, which shelves backwards and is surmounted by a rounded roof.

1. EURHODIA MORRISII, *d'Archiac and Haime.* Plate XVIII, Figs. 1–7.

Pygorhynchus Morrisii, *d'Archiac*, 1850, *Hist. des progrès de la Géol.* t. iii. p. 248.

The thick test is long, rather depressed, ovoid at the tumid margin, broad in front, widest in front of the centre, on a line with the peristome, and tapering backwards to a posterior truncated edge. The apical surface is highest behind the centre and between the posterior ambulacra; it slopes slightly on a comparatively plane surface to near the end of the odd ambulacrum, and then merges into the boldly convex anterior portion of the test, which unites with the tumid margin. Behind, the slope is more sudden, and there is a rounded low keel, which reaches backwards along a slope very much less defined than the anterior convexity of the test, and which reaches to the edge over the supramarginal periproct. The keel and the test slope on either side rapidly to the sides of the test, so that this part is less tumid and narrower than the anterior portions. The posterior edge of the test is rounded, but is rather sharp; it is nearly straight transversely, but just a little incurved, and the broad shallow periproct-groove slopes upwards and forwards from it. The actinal surface is nearly flat, but there is a longitudinal and central depression, at the anterior end of which is the peristome; posteriorly the actinal surface is very slightly produced downwards.

The apical system is small and eccentric in front; there are four generative pores, and the madreporic is central; the outer pores are well developed. The anterior odd ambulacrum is straight, open, and the outer series of pores of the poriferous zones curves to the straight inner series. The interporiferous zone is broader than one of the poriferous zones. The pores of this and of the other ambulacra are conjugate, and the outer series are more elongate than the inner, which often are circular in outline; the pores of a pair are more widely spaced in the middle of the poriferous zone than at the extremities; and sometimes the conjugation is difficult to trace in the middle of the zone in some specimens. The pores of all the ambulacra are numerous, and are crowded near the apex in consequence of the narrowness of the ambulacral plates; and the pairs are separated by costal ridges, distinct in some parts and sparsely and irregularly ornamented with granules (Fig. 6).

The antero-lateral ambulacra are petaliform, slightly open, and are as long as but broader than the anterior odd ambulacrum. The poriferous zones are curved and even slightly sinuous distally, especially the posterior; and the interporiferous zone is broader than that of the other ambulacra. The posterior lateral ambulacra are the longest; they are nearly closed, form an acute angle, and reach back to within one and a half times their length of the periproct. The inner or posterior poriferous zones are narrow and nearly straight; and the outer are much the broadest and curved; the distinction between the two zones is very decided. All the ambulacra are nearly flush with the test, and their interporiferous zones are covered with a small tuberculation resembling that of the interambulacra of the upper part of the test. The tubercles are minute, sunk in a deepish scrobicule, and are rather wide apart. The tubercles are without order, but at the end of the anterior odd ambulacrum they assume a linear convergent arrangement, and form a series of successive vandykes, the angle being outwards and forwards. The ambulacra are continued over the margin, a very small pore being seen here and there.

The ornamentation of the upper part of the test is very equal and small; it becomes crowded at the margins, and at the under surface it gradually increases in the dimensions of the tubercles and scrobicules, until the largest are found close to the peristome. Beneath, the tubercles have a boss and mamelon and are perforate, and are separated by minute granulations.

The peristome is beneath the apical system, is longer than broad, elongate, longitudinally narrow, pentagonal, and narrowest and angular anteriorly. It is deep, and the floscelle is well developed.

These buccal petals are broad, nearly closed, a tubercle often interposing between the poriferous zones at their ends, wide apart; and their poriferous zones are well developed, and marked with grooves and costæ.

The poriferous zones have numerous pores in the outer row, and about half the number in the inner row, connected by grooves which are rather wide apart.

The inner pores are doubled in most instances; and very frequently the innermost series appear to be aborted and blind, possibly modified into sphæridia-pits. Two pores are within the peristome.

The anterior petal is usually the broadest, and is arched around by a small pitted space whose pits are rather deep and small and irregularly placed. This space is continued forwards, and also extends sometimes on both flanks of the anterior petal. The antero-lateral buccal petals are more pointed than the odd one, and are surrounded by a row of large tubercles.

The postero-lateral ambulacra also have a tubercle at their open distal end, and posteriorly they are bounded by the commencement of the median pitted space, which reaches forwards to the posterior edge of the dense peristomial lip. The buccal petals are slightly concave at their interporiferous zones; and these portions contract within and slope upwards into the mouth in flat stalk-like processes.

The interambulacra end, actinally, in short, slightly downward-projecting, broad processes or bourrelets, which are covered with an exceedingly delicate granulation. They pass upwards, forming the sides of the peristomial pentagon, and are concave externally between the phyllodes where they are in contact with the pitted spaces or regions of large tuberculation. The posterior pitted space reaches the posterior margin of the test, and diminishes gradually in width.

The periproct is large, transverse; and the broad edge of the slight posterior interradial keel overhangs it. The floor of the periproct, slightly concave and broad, merges into the posterior shelving process, which terminates in a rather sharp edge at the posterior truncation of the test.

Length of specimens.	Breadth.	Height.
$2\frac{6}{10}$ inches.	$1\frac{8}{10}$ inch.	1 inch.
$2\frac{2}{10}$ „	$1\frac{5}{10}$ „	not quite 1 „
2 „	$1\frac{4}{10}$ „	$\frac{11}{12}$ „
$1\frac{6}{10}$ „	$1\frac{1}{10}$ „	$\frac{7}{10}$ „

Locality. North-east of Petiáni, west of Kotri, Ranikot series (Survey-number G $\frac{280}{135}$); also at Jhirak, Ranikot series (Survey-number G $\frac{280}{1345}$).

Variety. With a narrow interporiferous zone to the odd ambulacrum; the test more elliptical and larger behind than the type; other structures the same.

Several specimens of this variety occur; and there is some variation in regard to their height and breadth; they are mostly smaller forms, but most are more than 1 inch in length.

Localities. South-west of Jhirak; hills east of Lynyan; from gypseous shales, Jhirak. Survey-numbers G $\frac{226}{183}$, G $\frac{280}{1285}$, G $\frac{250}{1215}$.

These are all from the Ranikot group.

Illustrations of the Species in Plate XVIII.

Fig. 1. The test, from above: natural size.
2. Side view: natural size.
3. Transverse outline.
4. Actinal surface: natural size.
5. Apical system: magnified.
6. Part of an ambulacrum: magnified.
7. The floscelle: magnified.

Genus PARALAMPAS, gen. nov.

Test of small size, suboval, high, and convexly inflated above, greatest elevation posteriorly eccentric; slightly concave beneath, margins very tumid.

Ambulacra petaloid, short, subequal, closely approximating at the extremities distally; poriferous zones equal; pores equal, round and conjugate.

Apical disk compact, slightly eccentric in front.

Peristome pentagonal, more or less eccentric in front, slightly widest laterally; floscelle well developed, with wall-like bourrelets.

Periproct suboval, supramarginal, high, overhung by a well-developed supra-anal rostration, with a more or less defined groove beneath.

Tubercles small, uniform, crowded, equidistantly placed, sunken in deep scrobicules; slightly larger and more widely spaced on the actinal surface.

This genus resembles *Rhynchopygus* to a certain extent in consequence of the overhanging character of the supra-anal portion of the odd interambulacrum, but differs widely in the great height and posterior eccentricity of the elevation of the test, and is further distinguished by the small and petaloid ambulacral rosette, the equal pores, the comparative simplicity of the floscelle, the absence of a median, pitted, actinal band, and the small and homogeneous character of the actinal tuberculation, which is very slightly larger than that above the ambitus. It differs from *Pygorhynchus* in the form of the test, the character of the ambulacra, the structure of the floscelle, and the absence of the median band. It is distinguished from *Echinanthus* by the form of the test, the supra-anal rostration, and the proportions and character of the petals and pores. From *Catopygus*, to which the form of the test presents a somewhat exaggerated resemblance, it is well defined by the character of the ambulacra, the concave actinal surface, and the structure of the floscelle.

1. PARALAMPAS PILEUS, sp. nov. Plate XV, Figs. 11–14.

The test is high, longer than broad, broadest posteriorly, very convex above, and rather concave below, except at the tumid margins. The sides of the test are swollen and project outwards more than the margins, and slope up roundly to the top. The greatest height is between the distal ends of the posterior ambulacra; and thence the test slopes forwards, slightly, to the apical system, which is eccentric and in front, and roundly and sharply backwards to the ridge over the narrow periproct, which is about two thirds of the distance from the margin. The transverse outline of the test above the ambitus is nearly semicircular, but there is a slightly angular summit. At the margin the test is rounded and narrow in front and broadly rounded behind; and there is a concave surface along the actinal median line.

The peristome is small, eccentric in front, transverse and pentagonal. There is a projecting ridge or lip from each interambulacral space or bourrelet; and traces of double pores are seen in one part of this badly preserved portion of the test.

The apical system is eccentric and slightly in front, and is moderate in size; the madreporiform body is central; and there are four generative pores. Near it, the interambulacral spaces are excessively narrow, in consequence of the rather abruptly broad petals of the trivium. The anterior odd ambulacum, the longest, is petaliform, passes along the anterior declivity of the test, does not reach the margin by a distance nearly equal to its length, is open distally, and has a very broad interporiferous zone. The poriferous zones are equal, rather narrow, and the pores are circular in outline or slightly elliptical. The pairs of pores are rather oblique, are crowded near the apex, and much wider apart distally; and the pores are conjugate. The ambulacrum is broadest midway, and is flush with the test. The antero-lateral ambulacra are shorter than the others, have a tendency to close, are petaloid and broad in the interporiferous zone. They diverge greatly, but are not transverse, and they do not reach to the most swollen part of the side of the test. The posterior ambulacra are rather close, and are narrower than the antero-laterals; they end very far from the periproct-groove, and more than their own length. The poriferous zones of the ambulacra have a close resemblance. There are 27 pairs of pores in the odd ambulacrum, and 25 in the others. The large interporiferous zones are very characteristic.

The peristome is beneath the apical disk.

The periproct is in a decided groove, with a shelving process, which reaches the tumid margin, and is covered at about halfway up the posterior part of the test by a roof-like ridge. The periproct is longitudinal rather than transverse.

The ornamentation of the test is that of very small tubercles or sunken areolæ; and there is a fair amount of intermediate raised reticulation.

Length $\frac{3}{4}$ inch, breadth $\frac{6}{10}$ inch, height $\frac{5}{10}$ inch.

Locality. Hills east of Lynyan, from gypseous shales, Ranikot series. Survey-number G $\frac{280}{130a}$.

Illustrations of the Species in Plate XV.

Fig. 11. The test, side view: natural size.
12. View from behind: natural size.
13. Marginal outline, from below.
14. The apical system: magnified.

2. Paralampas minor, sp. nov. Plate XVII, Figs. 1–4.

The test is small, almost hemispherical, stands on a small base beneath the overhanging tumid margins; it is as long as broad, and slightly longer than high, broadest midway between the peristome and the posterior margin, slightly truncated posteriorly, and decidedly concave actinally around the peristome. The marginal outline is elliptical, and broadest behind. The highest point superiorly is central, and is situated between the posterior ambulacra. The apical system is eccentric in front and on the rounded anterior slope. The peristome is more central than the apical system, and the periproct is high up, circular in outline, and at the top of the posterior truncation, which has a faint groove.

The apical system and subequal petaloid ambulacra are small; there are four generative pores, and a small central madreporic body. The anterior odd ambulacrum, well developed, is nearly closed; the pores, large and circular in outline, are conjugate; and the grooves are oblique; and the interporiferous zone is fairly developed. The antero-lateral ambulacra form a very open angle, are nearly closed; the conjugate grooves are oblique, and the posterior poriferous zone is more curved than the anterior. The postero-lateral ambulacra are nearly closed, are rather close together; and the conjugate grooves are oblique. The extremities of these ambulacra are about $1\frac{1}{2}$ times the length of the petals from the periproct. The interporiferous zones of the lateral ambulacra are narrow distally, and in all cases are sparsely ornamented like the surrounding interradial area.

The interradial areas are large, and are separated by the long continuations of the ambulacra beyond the petaloid portions. These continuations are broader than the ambulacra as they reach the margin, although narrow at the end of the petals; they are marked by a series of solitary pores on either side. The posterior interambulacrum is rounded between the ambulacra, and then slopes with a very equal convexity backwards and downwards, forming hardly a trace of keel, and reaches the periproct. The ornamentation of all the interradials is small, close, equal, and consists of small tubercles in sunken scrobicules, the intermediate raised portion of the test being scanty.

The peristome is sunken, subcentral, pentagonal, largest transversely, and deep. The floscelle is moderately well developed. The bourrelets are narrow and project downwards, with rounded edges; and the phyllodes are not petaloid, but are open externally and small peristomially. There is a slight reduplication of pores, and the first pair are very visible at the peristomial edge.

The actinal ornamentation is of the same character as the abactinal, but slightly larger.

Just above the rounded-off posterior margin the test is very slightly truncated; and there is a shallow median groove with a faint ridge on either side leading up to the periproct.

The length of the type is $\frac{5}{10}$ inch, and the extreme breadth is the same; the height is $\frac{4}{10}$ inch.

Locality. Hills east of Lynyan, gypseous shales in the Ranikot series. Survey-number G $\frac{280}{126}$.

Illustrations of the Species in Plate XVII.

Fig. 1. View from the side: natural size.
2. From behind: natural size.
3. The apical system and petals: magnified.
4. The peristome: magnified.

Remarks. This species is very nearly allied to *P. pileus*, but differs in the more conoidal and more tumid form of the test. The periproct is higher up, the median keel and the overhanging supra-anal ridge are much less developed, and the infra-anal groove is narrower and more clearly defined. The ambulacral petals are comparatively smaller, and the interporiferous areas narrower, than in the preceding species. These differences appear sufficient to warrant the recognition of the independence of this form, although it is quite possible that it may be the young stage of a well-defined variety of *P. pileus.*

Genus NEOCATOPYGUS, gen. nov.

Test of moderate size, tumid and high, subrotund marginally, greatest height posteriorly eccentric. Abactinal area convex, sides tumid and high; actinal surface convex. Posterior extremity subrostrate and prominent, tumid actinally.

Ambulacra petaloid, petals short and subequal, open at the extremity; poriferous zones subequal, pores unequal and conjugate. Extrapetalous pores single.

Peristome small and pentagonal, eccentric in front. Floscelle well developed; bourrelets forming an ornamented wall-like rim; phyllodes with an inner series of supplemental pores.

Apical disk small and compact, slightly eccentric in front; four generative pores; madreporiform body placed centrally.

Periproct small, subcircular or oval, supramarginal, placed at the extremity of the posterior rostration, by which the aperture is slightly overhung. The subanal area, which is tumid and rostrate, is faintly grooved.

Tubercles small, perforate and crenulate, sunken in deep scrobicules, intermediate space granular, the encircling ring of the scrobicule often well defined. Actinal ornamentation coarser than above the ambitus.

This genus recalls *Catopygus* to a certain extent, but is readily distinguished by the form of the test, the small ambulacral rosette, the single series of extrapetalous pores, the character of the floscelle, the position of the periproct, and the character of the posterior rostration.

The form is well defined, and further comparison with other genera of Echinolampinæ seems superfluous.

The forms included in this genus differ much from the modern *Catopygi*, and are as remote from them as from the Cretaceous forms.

1. NEOCATOPYGUS ROTUNDUS, sp. nov. Plate XVI, Figs. 1–10.

The test is very tumid, broadly oval or cordiform in marginal outline, rounded in front, rather pointed behind, broadest at a lateral projection, which is anterior to a narrowing immediately anterior to the faint subanal rostrum. The test is highest posteriorly midway between the distal ends of the posterior lateral ambulacra, and it slopes gradually in front to the very tumid ambitus, and more suddenly posteriorly to the periproct, which is three quarters of the distance from the upper part of the test to the lower; thence the outline of the test passes obliquely downwards and forwards. The sides of the test are tumid, and slope up gradually to the apex, and more suddenly to the slightly convex actinal surface. The apical surface is convex; and the convexity of the posterior interambulacral area is interfered with, along the median line behind the point of greatest height, by a shallow groove with faintly raised edges. This groove, with its edges, becomes slightly raised near the periproct; and the structure is continued inferiorly down to the rounded-off and slightly projecting posterior rostral process. The test is slightly longer than broad, and broader than high.

The apical system is small and rather eccentric in front; there are four generative pores; and the madreporic body is placed centrally and is slightly prominent. The ambulacra are small in relation to the surface of the test, do not extend beyond the moderately convex upper surface onto the tumid sides, and are subequal, petaloid, and do not close. They are nearly flush with the test. The interporiferous zones, slightly above the level of the test, are broadest at the commencement of the distal third, and are about double the width of a poriferous zone; and their ornamentation is of a few small tubercles in sunken scrobicules. The poriferous zones have the pores placed rather obliquely, and the outer set are larger and more oval than the rounder inner series. They are conjugate, and the costal ridges are granular. The pairs of pores are close, and the plates of the ambulacra are numerous. The posterior lateral petals are slightly the longest and contain the most pores; and the antero-lateral petals diverge greatly, forming an angle of about 60°–66°. A row of numerous single pores passes from each poriferous zone over the ambitus; and the two rows forming the extrapetaloid ambulacrum diverge on leaving the ends of the petals.

The interambulacra are wide and conform to the slight convexity of the test; their ornamentation is of sparsely distributed tubercles in sunken scrobicules, the intermediate surface being ornamented with granules which are often arranged in circles around the scrobicules, or the spaces may be minutely punctuated.

There is a certain gibbosity placed longitudinally along, or rather posterior to, the median suture of the interradial area between the antero-lateral and postero-lateral ambulacra.

The peristome is very small; it is more eccentric in front than the apical system, is pentagonal, with slightly re-enteringly curved bourrelets, and it is slightly longer transversely than longitudinally; and the floscelle is well developed. A wavy ornamented rim projects downwards from the bourrelets and from the sides of the proximal part of the phyllodes. The buccal ambulacra or phyllodes have open ends, which expand into the long line of single pores, and they have supplementary pores and also central pits. The ornamentation of the test is coarser actinally, and some of it is within the poriferous zones of the phyllodes.

The periproct is small, supramarginal, low down; it is almost circular, or surmounted by a slightly projecting ledge of the flat grooved keel; and there is a faint groove leading from it downwards and forwards to be lost on the tumid posterior rostrum.

Length of the test $1\frac{4}{10}$ inch, breadth $1\frac{3}{10}$ inch, height 1 inch.

Locality. Hills east of Lynyan, from the gypseous shales in the Ranikot series. Survey-number G $\frac{280}{120}$.

There are many specimens of different sizes of this species in the collection.

Some of these are from an uncertain locality, and are numbered G $\frac{280}{128}$, but they evidently belong to the same species and can hardly be called varieties.

In all the tumid test, the slightly eccentric-in-front and small apical rosette, the more eccentric-in-front and small and transverse peristome, with a well-developed floscelle, the faint keel, and the projecting but low-down periproct and the extra-petalous row of solitary pores are very distinct and characteristic.

Illustrations of the Species in Plate XVI.

Fig. 1. The test, from above: natural size.
2. The test, from below: natural size.
3. The floscelle and peristome: magnified.
4. The test, side view: natural size.
5. The posterior end: magnified.
6. The transverse outline.
7. The apical system: magnified.
8. A small specimen, from above.
9. The ornamentation: magnified.
10. Part of an ambulacrum: magnified.

Family SPATANGIDÆ.

Subfamily SPATANGINÆ.

Genus HEMIASTER, *Desor*, 1847.

The test may be short and inflated, or dilate and cordiform.

Apical system subcentral, or more frequently eccentric posteriorly.

The paired ambulacra are petaloid, more or less unequal, placed in furrows; their poriferous zones are broad and equal, pores elongate. The odd ambulacrum often narrower than the rest, and placed in a less defined groove; its poriferous zones are very narrow, and composed of very small round pores forming a simple series of widely spaced obliquely placed pairs.

Peristome bilabiate, very eccentric in front.

Periproct on the posterior extremity.

A single fasciole, peripetalous, more or less angular, surrounding the ambulacral petals.

Tubercles perforate and crenulate, not sunken in scrobicules; small, uniform, and crowded on the abactinal surface, rather longer on the actinal surface.

1. **Hemiaster elongatus**, sp. nov. Plate XIX, Figs. 7–15.

The test is long, depressed, tumid at the ambitus, slightly convex actinally, rather rounded apically, highest posteriorly, posterior margin slightly truncated above a sharp plastron-point and below the elliptical transversely placed periproct. It is longer than broad, and broader than high.

The marginal outline is ovoid, broadest centrally, broader in front than behind, where the test diminishes in breadth rapidly. The anterior margin is well rounded, the groove not reaching to the ambitus; and on a line with the antero-lateral ambulacra there is some marginal flattening. A side view of the test shows the tumid margin sloping backwards more rapidly than forwards; the highest point is far back; thence the test slopes backwards rapidly over a very flat broad keel to overhang the periproct, and forwards more gradually but decidedly to the low tumid anterior margin. The test stands on a smaller base than the margin; and the height of the test diminishes rapidly in front of the very eccentric-in-front peristome. Posteriorly and below is the pointed plastron-end, and the test slopes rapidly upwards and backwards, and then nearly upwards to the periproct. The outline of the test seen from behind is depressed at the sides, pointed below, faintly rounded and keeled above. Anteriorly, the outline indicates a rounded actinal surface, showing the opening of the peristome, a low tumid margin, and a broad low ambulacral groove with a low keel on either side of it.

The apical system is slightly behind the centre of the test, is small, and is situated on a narrow transverse keel of the lateral interradia. The peristome is very eccentric in front. The periproct is situated about three fourths of the distance from the pointed end of the plastron to the summit of the test.

The apical system is compact and small; the madreporic body is small, and separates the posterior ocular plates, but does not extend into the posterior interradial area; there are only two generative pores, and they are situated at the tops of truncated cones separated at their bases by the granular surface of the madreporic. The cones are at the extremities of a narrow transverse ridge. The right and left antero-lateral generative plates are very small, and they are not perforated by pores; and the postero-lateral plates are the largest and are perforated. There is no posterior generative plate. The ocular plates are well developed, and are placed in hollows, and intrude on the generative-plate edges.

The odd anterior ambulacrum is in a shallow groove, which widens and shallows anteriorly until it is just lost at the ambitus; there is a keel on either side, which diverges from its fellow, and which, well developed near the apical system, gradually broadens and becomes lower anteriorly. The keels slope rather rapidly towards the base of the groove; and the ambulacral pairs of pores are situated partly on the base and partly on the slope. They are few in number, are oblique, and the pores of each pair are separated by a small tubercle. Beyond the fasciole the pairs become very rare.

The antero-lateral ambulacra, in shallow grooves, are small, form an angle of about 90°, are petaloid, very nearly closed, slightly sinuous, broadest in the outer half, and fairly rounded close to the fasciole which closes them. The poriferous zones are large and on different levels, the anterior being on the slope of the test, caused by the keel of the anterior odd ambulacrum, and the posterior nearly flat. The pores are conjugate, rather wide apart, elongate, and the inner are the smallest; near the ocular end the pores of the anterior poriferous zone are smaller than those of the posterior, and as a whole the anterior series are more bent than the posterior. The interporiferous zone is shallow, and not as broad as one of the poriferous zones. The postero-lateral ambulacra diverge nearly as much as the antero-lateral, are much smaller than the others, are slightly longer than broad, rounded, and nearly closed close to the fasciole, are in shallow grooves; and the pairs of pores are few, 8 to 11 in number. There are a few minute granules on the ridges between the pairs of pores, and there is a distinct longitudinal line in the interporiferous zones. Beyond the fasciole the pores of the ambulacra are in single series; and they reach the peristome, where they become more numerous.

The antero-lateral interradia are swollen by the keels of the odd ambulacrum, and become broader anteriorly; they are very narrow near the apex, between the pores of the odd ambulacrum and the anterior poriferous zones of the antero-lateral ambulacra; and this part is keeled. The postero-lateral interradia are also narrow at the apical system, and are formed there into a long but narrow keel; this expands rapidly into the general convexity of the test beyond the limits of the ambulacra. The posterior interradium is very faintly keeled between the ambulacra, and it rises gradually to a point rather posterior to them; it slopes on either side to the line of the continuation of the ambulacra, and posteriorly more sharply, and is rounded off just above the periproct. The plastron is long, narrow, pointed, and lowest posteriorly, is generally convex from side to side, and the lip on the anterior end is slightly prolonged downwards.

The peristome is small, much the longest transversely, has a rim, and is round at the sides. The periproct is elliptical and broader transversely than from above downwards; there is a very faint flattening just below it.

The fasciole is well developed and is peripetalous. It is broad, and marked with many rows of granules at the end of the antero-lateral petals; it passes thence backwards slightly, and then turns towards the apical system, running nearly parallel with the antero-lateral petals for a short space; then it crosses over, not going far into the angle between the petals, narrows considerably, and passes backwards and inwards to reach the distal end of the posterior petals. It enlarges as it bounds their end, and then crosses over the keel, narrowing and having a slight convexity backwards. In front, the fasciole starts from the end of the antero-lateral petals, narrows and mounts the keel on the outside of the odd ambulacrum, taking a direction forwards and inwards; still narrowing, it passes forwards, but with a less inward course, and crosses the median line with a sharp curve, enlarging again there, the convexity being forwards; this part of the fasciole is slender, and is much nearer the ambitus than the apical system.

The ornamentation is remarkable for its variation in size and detail. Posteriorly the ornamentation is small, and consists of very small tubercles with still smaller ones between them; they are crowded, and give a granulated appearance. This ornamentation increases in size and definition on the sides towards the fore part of the postero-lateral interradia; and the tubercles are seen to be surrounded by a row of smaller ones, or they merge into a raised rim around. In the antero-lateral region this ornamentation is still larger and more pronounced; but along the line of the odd ambulacrum, over the ambitus, the tubercles become smaller and rarer, and moniliform circlets of minute tubercles are seen. The tuberculation is large and distinct on the keel between the postero-lateral ambulacra and on the transverse keel beyond the generative pores; it is also large on the inner slope of the keels of the anterior odd ambulacrum, and it is largest and sparest of all below the ambitus in front of and at the sides of the peristome. The posterior ambulacra, actinally, are marked with an ornamentation of long and radiating moniliform lines of granules; and the plastrom between them has its ornamentation of rounded tubercles on flat scrobicules, small posteriorly and large in front; and the lines of tubercles seem to radiate from the posterior keel-end.

Height of specimens.	Length.
$\frac{7}{10}$ inch.	$1\frac{1}{10}$ inch.
$\frac{4}{10}$ "	$\frac{7}{10}$ "
$\frac{4}{10}$ "	$\frac{6}{10}$ "
$\frac{3}{10}$ "	$\frac{5}{10}$ "

The largest specimen is $\frac{7}{10}$ inch broad. Some forms are slightly broader in front than others; and rarely there is an impression of the groove at the ambitus in front. The young forms are more globular than the older ones.

Localities. In the Ranikot series, north by east of Petiáni (Survey-number G $\frac{280}{135}$); hills east of Lynyan, from brown limestone (G $\frac{280}{128}$. and G $\frac{280}{127}$); east of Kandaira, in Vero plain (G $\frac{226}{135}$) and Jhirak (Survey-number G $\frac{280}{241}$).

Remarks. We are unacquainted with any species for which the present form might be mistaken. It is especially distinguished by the elongate test, the egg-shaped and regularly rounded marginal contour, and the characters of the petals and apical disk.

Illustrations of the Species in Plate XIX.

Fig. 7. Upper view: natural size.
8. Actinal surface: natural size.
9. The apical system: magnified.
10. The longitudinal outline: natural size.
11. Ornamentation on the anterior keel: magnified.
12.
13. } Outlines of young forms: natural size.
14.
15. Test, from behind: natural size.

2. HEMIASTER, sp.

There is a single small example of what was probably a *Hemiaster* in the collection; but the test is unfortunately so much crushed, weathered, and badly preserved as to be perfectly undeterminable. From such characters as can be made out, the form was possibly identical with, or at any rate nearly allied to, *H. digonus*, d'Archiac.

As this form is very abundant in a higher horizon, it is unnecessary to refer to the species at greater length in the present place; and the specimen is so unsatisfactory that we should not have mentioned it, excepting for the interest which attaches to it as a probable record of the presence of that species in the Ranikot series.

Locality. North by east of Petiáni, west of Kotri, Ranikot series. Survey-number G $\frac{280}{133}$.

Genus LINTHIA, *Merian*, 1853.

(See *anteà*, p. 17, part i.)

1. **Linthia Indica**, sp. nov., and a variety. Plate XX, Figs. 1–8.

The test is broadly oval, depressed, with an angular outline, notched in front, narrowed and truncated behind. It is widest just behind the centre, and the marginal outline is wider and more rounded in front than behind. The apical surface slopes in front from a low, rounded, sharp, narrow keel, which separates the posterior ambulacra and overhangs the periproct, the highest point being behind the posterior ambulacra. The actinal surface is slightly rounded and convex; and there is a downward-projecting posterior point to the plastron. A front view of the test shows the tumid and somewhat nodulose margins or flanks, the anterior groove for the odd ambulacrum keeled on either side near the apical system, and behind it the sharp narrow triangular outline of the keel of the posterior interradium.

The apical system is slightly in front of the centre, is small, and is placed on a depressed area formed by the junction of the raised posterior keel, the narrow keels of the lateral interradial areas, and the keels of the anterior odd ambulacrum.

There are four generative pores, and the anterior and posterior pairs are rather close together; the anterior pair of pores are much closer than the posterior pair, which are wide apart. The right anterior plate is in relation with the madreporic body, which separates the posterior pair of plates widely, and which passes slightly backwards and separates the posterior ocular plates. The anterior generative pores are on a line with the ocular pores of the odd and antero-lateral ambulacra, and the posterior ocular pores are on a line with the anterior and posterior generative pores.

The peristome is rather close to the anterior margin, and the periproct is high up in the posterior truncation.

The groove for the anterior odd ambulacrum is rather deep, and becomes shallower and broader towards the margin, which it notches decidedly; it is continued more or less on to the peristome.

A few sets of pairs of pores are on the flanks of the groove, and the twelfth pair are crossed by the fasciole. Each pair is in a shallow hollow, and the pores are oblique and separated by a granulation.

The antero-lateral ambulacra are long, on rather deep grooves, faintly flexuous, rounded, and nearly closed where the fasciole bounds them, and narrow apically. The anterior poriferous zone is on the flank of the groove, the narrow or interporiferous zone is on the floor, and the posterior poriferous zone on the other flank, and, like its fellow, is steeper near the apical system than in the outer third. The pairs of pores are separated by granular costæ; and there are from 20 to 23 pairs of pores. The angle formed by the diverging ambulacra is about 110°–115°.

The posterior lateral ambulacra are small, petaloid, close, separated by a narrow keel, rather deep, nearly closed, rounded where in contact with the fasciole, and the outer poriferous series is more curved than the inner. There are from 14 to 16 pairs of pores. Their grooves are comparatively shallow.

The interradial areas are narrowed at the apex, and form moderately elevated, narrow, rounded keels, ornamented with a few distant tubercles. On the flanks the plates have a slight bulge; and thus a series of longitudinal elevations is formed, rendering the test slightly gibbose.

The ornamentation is largest in the anterior interradium, and especially on the margins, and it becomes larger and sparer near the peristome. It is smaller in the lateral interradia, behind a narrow line of minute granulations resembling a fasciole, which passes along the surface of the extrapetaloid part of the antero-lateral ambulacra. The ornamentation consists of low rounded tubercles or faintly rounded scrobicules. The surface around the peristome is free from ornamentation; and the plastron has a large ornamentation in regular oblique rows, which diminishes towards the posterior point.

The peristome is broader than long, is narrow from behind forwards, rounded at the outer angles, and is on the whole slightly curved and crescentic. The posterior lip is on a lower level than the anterior edge; the whole edge has a rounded-off rim. The ambulacral pores are scanty in number.

The periproct is oval, longitudinal, high up, and is in the posterior truncation, which is slightly hollowed out and bounded by faint ridges which enclose an oval space and pass over the margin to unite at the point of the plastron.

The peripetalous fasciole is in relation with the gibbous swelling of the plates along its course. It is broad at the rounded ends of the antero-lateral petals, and passes forwards and inwards as a narrower band to a gibbosity on the keel of the odd ambulacrum, over which it passes with a bend, the convexity forwards, not far from the margin. Behind, the fasciole passes along the edge of the end of the antero-lateral ambulacra, backwards and inwards to a gibbosity, and then enters the angle, passing close to the commencement of the narrow keel of the lateral interradium. Thence it reaches the anterior edge of the posterior petal, which it bounds; turning round the termination of the petal, it crosses directly over the narrow posterior keel to the other side, and pursues a corresponding course. The fasciole is broadest close to the outer part of the antero-lateral ambulacra, and is narrow elsewhere.

The lateral fasciole is very narrow; it starts from the gibbosity behind the outer part of the antero-lateral ambulacrum, which is marked with the peripetalous fasciole, and passes backwards and downwards to reach the lower part of the truncation close to the margin of the test, which it crosses with a downward curve.

There are many specimens of this *Linthia* in the collection from the Ranikot series: some have been slightly crushed; others (which are younger) have not. There appear to be two forms—that which has just been described, and a smaller. These last have a more globose and less depressed appearance; but in all the other points they correspond with the first.

Length of the type specimens.	Breadth.	Height.
$\frac{18}{20}$ inch.	$\frac{17}{20}$ inch.	$\frac{14}{20}$ inch.
$\frac{19}{20}$,,	$\frac{19}{20}$,,	$\frac{13}{20}$,,
$\frac{18}{20}$,,	$\frac{17}{20}$,,	$\frac{12}{20}$,,
$1\frac{1}{20}$,,	1 ,,	$\frac{12}{20}$,,
$\frac{14}{20}$,,	$\frac{14}{20}$,,	$\frac{12}{20}$,,

Length of specimen of variety.	Breadth.	Height.
$\frac{18}{20}$ inch.	$\frac{17}{20}$ inch.	$\frac{13}{20}$ inch.
$\frac{14}{20}$,,	not quite $\frac{14}{20}$,,	$\frac{12}{20}$,,

Locality. North-east of Band Vero, Ranikot series. Survey-number G $\frac{259}{130}$.

Illustrations of the Species in Plate XX.

Fig. 1. Actinal view.
2. Side view.
3. Apical system: magnified.
4. Side view of variety.
5. Fig. 1 from above.
6. Posterior view.
7. Young form: side view.
8. Posterior view.

Remarks. We were at first disposed to refer this form to the *Linthia Arizensis*, d'Archiac, sp.; but a careful study of the specimens contained in the collection has convinced us that the differences are greater than would justify us in maintaining such a conclusion. The outline of the test is broader, more angular, and with prominent gibbosities; the posterior height is much greater, the anterior slope is more rapid, the posterior sloping truncation is concavely impressed; the ambulacra are in much deeper grooves; the anterior petals are wider and more rounded at their distal extremities, and the posterior pair are directed more backward and consequently at a smaller angle of separation; on the actinal surface the plastron is broad and well tuberculated, and the bare ambulacral areas are comparatively narrow; and, finally, the peristome is situated further from the margin.

In the variety (Plate XX, Fig. 4) the resemblance to *L. Arizensis* is still closer, excepting that the height of the test is greater and more tumid, and the actinal surface is also more tumid, the ambulacra are less deeply sunken, and the posterior pair are comparatively a shade longer than in the type. This form is unquestionably the representative of *L. Arizensis* in the Ranikot strata.

This *Linthia* is distinguished from *L. Sindensis*, Duncan and Sladen*, from below the Trap, in the angle made by the antero-lateral ambulacra, the size of the posterior ambulacra, and the position of the peripetalous fasciole. There is also a great distinction in consequence of the difference in the position of the apical system.

The older form has wider-apart antero-lateral ambulacra than the species *Indica*, and it has the apical system well in front of the centre. This is not the case in the Ranikot form, which, in the position of the apical system, resembles somewhat the Schizasters.

Linthia Indica is an approach to the genus *Schizaster*; and had it a more attenuated posterior part, and the antero-lateral ambulacra closer to the anterior, and the pores crowded in the odd ambulacrum, it would be a *Schizaster*.

2. Linthia, sp. Plate XX, Fig. 9.

A specimen much worn on the upper surface, and nearly entirely destroyed actinally, is in the collection from the Ranikot series. There are some points about the form which ally it with some of the large Nummulitic Linthias; but until better specimens are obtained it is not necessary or advisable to give it a specific name, especially as it has considerable affinities in some points with *Linthia Delanouei*, of De Loriol, from the Nummulitic of Egypt.

The shape of the outline of the test is cordiform, about as long as broad, slightly broadest in front, with a slanting rostrum posteriorly. The apical system is nearly central from the periproct to the slight anterior notch, but eccentric in front from the lower end of the rostrum to the same position in front.

The anterior groove is moderately deep near the apical system, and broader and shallower towards the front, where it faintly notches the ambitus. The pores in it are small, separate in pairs, with a rounded costal elevation between each pair on the slope of the side of the groove. There are about 20 pairs of pores; and the pores of each pair are separated by a small tubercle.

The antero-lateral petals are large, long, deep, and straight; they are broadest on the outer third; and the anterior poriferous zone is more curved than the posterior, which is slightly the shortest. The pores are numerous, are on the vertical sides of the ambulacra, are large, very conjugate, and separated by wide ridges; they are smallest near the ocular plate. There are about 40 pairs in the anterior poriferous zone, which measures 21 millim. in length. The interporiferous zone is broad, and occupies nearly the whole breadth of the floor of the groove; it is narrower than a poriferous zone. The angle made by the antero-lateral ambulacra is 120°.

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* See Plate IV. Part I. Echinoidea from the infra-Trap.

The postero-lateral ambulacra, 15 millim. in length, are straight, ovate-lanceolate, deep and narrow, form an angle of about 55°; and their pairs of pores (about 30 in number) are large, placed on the nearly vertical sides of the groove, and are separated by wide costal projections. The interporiferous zone is large, and occupies the surface of the ground-floor.

The apical system is broken, and nothing satisfactory can be made out about the number of the plates and pores; but, from the large size of a posterior pore and the very narrow ridge of the anterior interambulacrum, it is probable that there were only one pair of generative pores.

The anterior interradials have sharp keels, very narrow near the apex; and the plates near the ambitus are nodulose. The keel of the lateral interambulacrum is broad and not very high, and that between the posterior petals is broad and enlarges posteriorly. The posterior part of this interradial area is truncated, and forms an oval slightly re-entering surface, high up in which is the large ovoid periproct. Faint traces of a peripetalous fasciole exist, which passes far in front over the ambulacrum, and which does not enter far between the petals. The ornamentation is scanty, and consists of small flat tubercles in slightly sunken scrobicules surrounded by circlets of miliaries. The ornamentation is larger and scantier in front and beneath anteriorly. The tubercles are perforate and crenulated and weathered.

The height of the test is unknown; the length is $2\frac{3}{10}$ inches, and the breadth on a level with the apical disk is the same.

Locality. North-east of Band Vero, in the Ranikot series. Survey-number G $\frac{280}{130}$.

Illustration of the Species in Plate XX.

Fig. 9. The test, from above: natural size.

Genus SCHIZASTER, *Agassiz*, 1836.

Test cordiform, more or less inflated, high posteriorly and sloping to the front.

Apical system eccentric posteriorly, often to a considerable degree.

Ambulacra petaloid, unequal, sunken in deep grooves. The anterior pair flexuous, directed to the front, and not very widely divergent; the posterior pair very short and slightly arched proximally. Poriferous zones equal, pores oblong and conjugate. The odd ambulacrum sunken in a deep wide furrow, of which the margins form keels; its poriferous zones are long and composed of numerous pores, which may be disposed in crowded pairs forming a simple series, or the pores may be so crowded as to form two irregular series in each zone.

Peristome eccentric in front, bilabiate, the inferior lip very prominent.

Periproct oval, at the summit of the posterior extremity.

Two fascioles, a peripetalous and a lateral, the latter diverging from near the extremities of the anterior ambulacra and passing beneath the periproct.

Tubercles perforate, crenulate, small and crowded on the abactinal surface, but larger beneath the ambitus. The tubercles are not sunken in scrobicules, but are surrounded by a small prominent disk.

1. Schizaster alveolatus, sp. nov. Plate XX, Figs. 10–14.

There is a crushed specimen of *Schizaster* in the collection of Echinoidea from the Ranikot series, which has much of the abactinal surface, flanks, and posterior parts preserved, and which is deficient in the actinal region. It is of a brown colour; and the anterior odd ambulacrum and the left antero-lateral petal are filled with matrix and more or less fragmentary small spines; and the crushing has forced the apical end of the anterior interambulacra downwards and has obliterated the apical system. Actinally, the broken test is filled with brown matrix with Nummulites in it. At first sight the form resembles *Schizaster Newboldi*, d'Archiac & Haime, as delineated in the 'Animaux Fossiles de l'Inde;' but when compared with the types of that species, which are preserved in the Museum of the Geological Society, it will be noticed that there are specific distinctions, especially in the relative length of the ambulacra and the number of pairs of pores in them. Moreover the condition of the specimens of *S. Newboldi* really prevents them from being of real value. It appears also that one of the three types thus named is not of the same species, or possibly not of the same genus, as the others.

The general shape is tumid, largest posteriorly, highest just behind the apical system, sloping gradually in front and rapidly down the truncated posterior portion to a sharp point of the convex and semi-keeled plastron. The test has its greatest breadth slightly behind the apical system.

The apical system is slightly posterior; its details are invisible. It is small and is placed on a depressed area between the sharp suddenly-rising anterior keels, the broader but still higher and less decided narrow ridges of the lateral interradials, and the slightly narrower and more pronounced keel between the postero-lateral ambulacra.

The anterior groove is large, deep, broad, excavated at the sides, which are high within the fasciole, flat nearly on its floor; it becomes broader and shallower towards the margin, which is moderately notched, and the groove persists slightly to the peristome. The pairs of pores are placed partly on the sides of the groove and partly on the floor—one pore (the outer and larger) being at the junction of the side and floor, and the inner and smaller obliquely in front of the other and on the floor. Each pair of pores, of which there are about 15 visible, is separated from its neighbours by a broad costal elevation, and each pore is separated from its fellow by a broad tubercle. The ornamentation of the floor of the groove is not seen, except in the form of a few very minute granules near the apical region.

The antero-lateral ambulacra are deep, slightly sinuous, rounded at the extremity, which flares outwards slightly, narrowest and shallowest near the apical system. The sides of the groove are nearly perpendicular in the midst of the petal, and they slope at the distal and become shallow at the proximal end. The interporiferous zone is well marked and broad, but it is not as broad as one of the poriferous zones. These are unequal, the anterior being the longest and curving outwards and slightly backwards to nearly meet the straighter posterior zone, where the fasciole closes the petal. The pairs of pores are small and close together near the ocular plate; and there are about 7 small pairs in the posterior zones, and 10 in the anterior before the considerable enlargement of the pores commences to be seen. The pairs then increase rapidly in size, are placed nearly vertically, are wide apart, large, and are separated by broad costæ ornamented with a linear ridge. There are about 26 large and small pairs of pores in the anterior zone. The angle formed by these ambulacra is rather less than 90°.

The postero-lateral ambulacra are about half the length of the antero-lateral, are much narrower, shallower, and form a much smaller angle. They are rather close, being separated by a keel, are deep, petaliform, rather rounded at the end, and widest at the junction of the first and second thirds of their length. The interporiferous zone is moderately broad, but it has not the breadth of one of the poriferous zones; and these are on the nearly vertical side of the ambulacra. The pairs of pores are small and close near the ocular plate, and elsewhere are wide apart and large and separated by a ridge on a costa with or without granules. There are about 15 large and small pairs of pores in the poriferous zones.

The interradial areas have the plates well marked, and they are usually gibbose, so that the vertical lines of suturing are somewhat depressed. The anterior rise as sharp keels on either side of the odd ambulacrum, and they become narrow and suddenly slope backwards and downwards in front of the line of the apical system. On either side, externally, the keel slopes suddenly to the margin of the antero-lateral ambulacra; and in front the keels become wider apart, broader, and lower where the fasciole crosses. Beyond that spot the test swells out on either side, being faintly notched along the median line. The lateral interradials are narrowed and broadly keeled near the apex and are tumid along the plates, where there are globosities.

There is a sharp, convex, rather broad keel between the posterior ambulacra, which broadens out and becomes lower posteriorly, and it merges into an oval surface more or less truncated, on the upper part of which is a large ovoid periproct.

The peripetalous fasciole is broad at the terminations of the antero-lateral ambulacra; it passes backwards and inwards to a nodule on a plate about halfway between the end of the ambulacra and the most projecting part of the keel of the lateral interradium near the apical system. This part is narrow, and becomes small near the nodule. A small portion of test is between the fasciole and the posterior poriferous zone. Then the fasciole, diminished in size, reaches the projection on the keel, and thus is well within the space between the petals. Still narrowing, it reaches the edge of the posterior ambulacra at their outer third, passes round the end of the petal, and crosses directly over the keel to the other side. In front, the broad fasciole at the end of the antero-lateral ambulacra passes forwards inwards, mounting the flanks of the keel of the odd ambulacrum to a gibbosity, and becomes narrower just before reaching this. Thence it passes forwards, widening, and then diminishing to a point on the top of the keel well forward and in front of the first visible pairs of pores. It crosses the floor of the groove in an arched form, convexity forwards. The structure is that of exceedingly minute granules.

The lateral fasciole is very narrow, and starts from the gibbosity posterior to the antero-lateral petals and about halfway between their ends. It passes obliquely backwards and downwards, and reaches the margin below the truncation for the periproct. Curving downwards around, it meets its fellow of the opposite side.

The ornamentation is remarkable. It consists at the ambitus on either side of the anterior groove of a few large tubercles on one side of a nearly circular and somewhat imbricating raised scrobicule. A few miliaries exist on the test, where there are no scrobicules. Towards the groove and above, the tubercles are closer and smaller, and they become smaller and closer on the keel and its slopes, the smallest being near the apical system.

On the flanks of the test in the anterior interradium the tuberculation is larger than on the keel, and it is comparatively wanting along the sutures and along the continuation of the petaloid ambulacral plates.

Externally and on the flanks of the test the ornamentation is at first small and close, and then it gradually increases in size and sparseness. A medium-sized tuberculation, rather close, covers the posterior interradial. The tubercles are rather low and squat, but they have small mamelons and are perforate and crenulate. In some places there are circlets of, or irregularly-placed miliaries; and the scrobicules sometimes are broken up, as it were, into circlets of miliaries. On the inner slope of the keels of the anterior interradials the tubercles are rather larger and scarcer than just on the outer slope; but they are largest nearest the pores, and become smaller in front.

The length of the specimen is $1\frac{9}{10}$ inch, the breadth is $1\frac{7}{10}$ inch.

Locality. Gari-wari Gorge, on the road from Bádha to Lynyan, in the Ranikot series. Survey-number G $\frac{280}{129}$.

Illustrations of the Species in Plate XX.

Fig. 10. The test, from above.
11. The test, from behind.
12. Ornamentation near the ambulacra: magnified.
13. An antero-lateral petal: magnified.
14. The apical system, from a specimen from Kach: magnified. Possibly closely allied, but not of the same species.

There is considerable resemblance between this form and several species of *Schizaster*. The shape of the details of the upper surface cause it to resemble somewhat

S. d'Urbani (Forbes), of the Barton series of Alum Bay. It has considerable affinities with *S. africanus*, de Loriol, from the Nummulitic of Egypt. But the whole of the test not being accessible, it is impossible to do otherwise than state that the form belongs to the Schizasters with deep and keeled anterior grooves, deep and sinuous antero-lateral ambulacra, and small posterior petals and only two generative pores. There is a *Schizaster* from Kach which is allied to this form; but there are specific distinctions. But as it is probable that the Ranikot species had only two generative pores, we reproduce, with considerable hesitation, however, the details of the form from Kach.

Genus PRENASTER, *Desor*, 1853.

Test tumid, ovoid, regularly rounded in front, truncate behind.

Apical system very eccentric in front.

Ambulacra subpetaloid, narrow, almost straight; the anterior pair widely divergent, almost transverse, placed in very faint grooves, open at the extremities. The odd ambulacrum is scarcely visible, and nearly flush with the surface of the test, there being no anterior goove.

Peristome bilabiate, inferior lip prominent.

Periproct oval, at the summit of the posterior extremity.

Two fascioles, a peripetalous and a marginal. The peripetalous fasciole is incomplete and wanting in front, not extending beyond the point of junction with the marginal fasciole. This latter completely surrounds the test, dipping far down in front (sometimes so much as to appear on the actinal surface), and passing posteriorly below the periproct.

Tubercles are small and inconspicuous, perforate, crenulate, sunken in scrobicules.

1. **Prenaster oviformis**, sp. nov. Plate XIX, Figs. 1–6.

The test is subovoid, long, tumid, rounded in front, at the sides, and above, and truncated behind. It is longer than broad and broader than high, and is highest centrally, and the slope is sharpest anteriorly. Below, the surface is convex.

The apical system is eccentric in front, and the peristome also. The periproct is close to the top of the posterior truncation, which merges superiorly into a projecting point.

The apical system is small; and there are four generative pores, the posterior pair being rather the widest apart. The madreporic disk, in connexion with the right anterior plate, passes backwards, separating the posterior lateral generative plates, also separating the ocular plates of the posterior lateral ambulacra in a very slight degree.

The ocular pores are small but distinct, and are at the bottom of minute hollows in their plates.

There is no anterior groove; and the very minute series of pores of the odd ambulacrum are separated by a slight, flat, low ridge, which is narrow close to the apical system, and enlarges to the ambitus. The ornamentation of this wedge-shaped, triangular, and slightly elevated ridge is smaller than that of the interradials on either side. On its flanks and looking upwards and outwards are the pairs of pores of each poriferous series. They are very small, oblique, and in slight hollows; a minute tubercle intervenes between the pores of each pair, whilst the pairs are separated by a ring of miliaries.

The pores cease before the position of the fasciole is attained; and a few are visible close to the mouth.

The anterior lateral ambulacra are long, slender, narrow, crooked, nearly flush with the test (so slight is their groove), open at the end, and nearly transverse (so great is their open angle). Each ambulacrum has a decided curvature, the concavity being directed forwards in the outer half, and posteriorly near the apical system.

The interporiferous space is very narrow; and the posterior poriferous zone is slightly larger than the anterior. The pores in the anterior poriferous zones are smaller than those of the posterior, are very slightly elongate in outline; those of the posterior zone are unequal in size; the row nearest the interporiferous zone consists of smaller and circular or faintly oval or elliptical pores, whilst the posterior row contains larger pores which are elongate ellipses. The pores are conjugate and well separated; the cross-banding has a row of miliaries on it. There are about 26 pairs of pores, and those nearest the apical system are very small in proportion to the others.

The posterior ambulacra, slightly shorter than the antero-lateral, form an acute angle with each other, are in a slight groove, which is much more decided than that of the others, are closed at the end, where they are in contact with a fasciole, and are straight. Narrower than the anterior lateral, the posterior ambulacra have smaller pores, which are circular, oval, and elongate in outline. At the peristome the lateral and posterior ambulacra are represented by large wide-apart pores, and they crowd out the posterior lateral interradial areas 1 and 4 from the margin of the peristome.

The anterior interradials are rounded off; and there is a faint elevation in the angle formed by the ambulacra at the apical system; a rounded low keel is on the lateral interradials; and the posterior one has a convex surface above, which is narrowed near the apical system. Posteriorly, the odd interradial slopes slightly to the rear, and then is truncated, its direction being nearly vertical; but there is a slope backwards to the margin. This part is broad, has a very faint vertical groove below the periproct; and this is large, widely open, and nearly circular or elongate in outline.

Actinally, the interradials are convex, and the posterior has a well-developed plastron between the long narrow anterior ambulacra. It has a broad low central keel reaching from the posterior projecting point forwards to the mouth, where it reaches downwards slightly, and forms the base of the hind lip. The plastron has an ornamentation of very regular hexagonal spaces, bounded by raised margins (the united scrobicular raised edges), environing a flat areola, on which, nearest one end, is a boss and mamelon, which is faintly perforate and crenulate.

The peristome is small, has a very decided posterior lip, which is on a lower plane than the rest, and the opening is broader than long. The grooves of the ambulacra are tolerably developed there.

The lateral fasciole is narrow, and slopes forwards and downwards on the flanks, close to the part of greatest bulging, so as to reach the front, below the ambitus, and about midway between the mouth and the most projecting part of the anterior region of the test. It crosses over in front of the peristome to become continuous with that of the other side. Posteriorly this fasciole suddenly dips below the periproct in a downward curve, and passes to the opposite side. It is slightly narrowest posteriorly.

The incomplete peripetalous fasciole crosses the posterior interradial space, with a faint backward curve on a line with the ends of the posterior ambulacra. It closes their ends and then passes forwards, then curves suddenly downwards remote from the antero-lateral ambulacra, to join the lateral fasciole. It is a narrow band, and is of the same breadth as the hinder part of the lateral fasciole.

Thus the antero-lateral ambulacra are remote from the fascioles.

The test is profusely ornamented with a small tuberculation of different sizes. The smallest tubercles, situated within a raised margin in which they are sunken, are in the posterior and postero-lateral interradials above. This kind is also seen below; but the larger is observed below and especially on the plastron. In front of the descending part of the peripetalous fasciole, the raised margins are formed by aggregations of miliaries, and a larger and rounder scrobicule results with a well-developed boss and mamelon. This larger ornamentation is common over the front, except along the line of the anterior odd ambulacrum, and it is very decided inferiorly and near the peristome. The posterior ambulacra actinally and at the edge of the plastron have an ornamentation of circular minute pits.

Remarks. This species presents some resemblance to *P. Desori*, Cotteau, which is perhaps its nearest ally; but it differs from the Pyrenean species by its more elliptical form and its relatively greater disproportion of length to breadth. The test of the Sindian specimen is comparatively less high, and the truncation of the posterior extremity slopes downwards and outwards from the dorsal area. The structure of the antero-lateral ambulacra separates the form from *Agassizia*.

Length 1 inch, breadth $\frac{8}{10}$ inch, height $\frac{7}{10}$ inch.

Locality. North-east of Petiáni, Ranikot series. Survey-number G $\frac{280}{133}$.

Illustrations of the Species in Plate XIX.

Fig. 1. View from above: natural size.
2. Actinal surface: natural size.
3. Side view: natural size.
4. Posterior view: natural size.
5. Part of the odd anterior ambulacrum and ornamentation: magnified.
6. Part of an antero-lateral ambulacrum: magnified.

Genus METALIA, *Gray.*

1. **Metalia Sowerbyi**, *d'Archiac*, sp.

Brissopsis Sowerbyi, *d'Archiac* (1850), *Hist. des progrès de la Géol.* t. iii. p. 251.
Brissopsis (?) Sowerbyi, *d'Archiac & Haime* (1853), *Anim. foss. de l'Inde*, p. 220, pl. xv. fig. 7 *a*, *b*.

A single example of this form, in very bad preservation, occurs amongst the Ranikot Echinoidea. The condition of the specimen is most unsatisfactory, all structure and detail having been destroyed by weathering; and we are only able to determine the species by comparison with a large series of perfectly preserved specimens from the Khirthar strata, which are identical with MM. d'Archiac and Haime's badly-preserved type specimen in the collection of the Geological Society of London. Further remarks on this species are deferred until the description of the Khirthar series; but we may, however, mention in conclusion that MM. Desor, de Loriol, and other writers have been misled, by the incorrect drawing of the form in the 'Animaux fossiles de l'Inde,' in placing the species under *Prenaster*.

Locality. North by east of Petiáni, west of Kotri, Ranikot series. Survey-number G $\frac{180}{135}$.

IV. *Remarks on the Genera and Species in the Ranikot Series.*

There are 41 species and 1 variety in this fauna. The species *Rhynchopygus Caldeyi*, d'Archiac, sp., mentioned also, was probably placed accidentally in this series by the collectors.

The number of species of regular Echini in the series, admitting the distinctness of those forms which, although they can be differentiated from their congeners, are not sufficiently well preserved to be defined specifically, is considerable. There are 17 species and one variety. There are two species of true *Cidaris* and three of *Phyllacanthus* (*Rhabdocidaris*). Moreover an examination of the spines found in the beds indicates the former presence of *Porocidaris*. The species of *Cidaris* from below the Trap is not represented in the Ranikot beds; and none of the Cidaridæ of these deposits pass upwards into the Khirthar series.

One species of the genus *Salenia*, characterized, however, by the presence of an optic plate within the anal ring (almost an exceptional condition in the fossil species) is represented by several specimens*. It has also a peculiarity about the ambulacral pores. The genus is not represented in the other Nummulitic strata of India.

The *Cyphosoma*, a common form, has the peculiarity of having the tubercles of the interradial areas larger than those of the ambulacra. But this is the only exception to the usual generic attributes. Another species, not sufficiently well preserved to be diagnosed, is normal in respect of the uniform size of the tubercles.

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* See optic plates in two species figured by Cotteau, Péron, and Gauthier, Ech. Foss. Algér. fasc. 5.

The new genus *Acanthechinus* is not without alliances with *Stirechinus*, a Miocene or Pliocene form from the Sicilian Tertiaries; and the singular genera *Eurypneustes* and *Æolopneustes* are unique, although they clearly represent such genera as *Micropsis* and *Orthopsis*, which are common in other Nummulitic faunas. But the generic distinctions are very evident.

The most interesting forms of the Echinoidea in the collection are those which must be temporarily classified amongst the Temnopleuridæ. The apical system and ornamentation of the *Dictyopleuri* separate them from *Temnechinus* and *Temnopleurus*. The ornamentation recalls that of *Glyphocyphus* and *Temnechinus lineatus*, Duncan, of the Australian Cainozoic strata. It greatly resembles that of the forms classified by d'Archiac and Haime under the genus *Temnopleurus*, they not being *Temnopleuri* on account of the absence of true pits at the angles of their sutures. They have not the apical system perfect; and we range them in our genus *Dictyopleurus* provisionally, trusting to obtain perfect specimens from higher horizons.

With regard to *Arachniopleurus*, it has a considerable range in space, as we have seen specimens collected in Persia and also in Kach. Probably *Paradoxechinus* of Laube, from the Australian Cainozoic (Tertiary), links our *Dictyopleurus* to *Arachniopleurus*. None of these forms have the true Temnopleurid penetration and undermining of the test; in fact, they have greater alliances with *Glyphocyphus* than with *Temnopleurus*; but the apical system of *Glyphocyphus* differs. Neither in the Egyptian nor European Nummulitic areas have these remarkably ornamented genera been distinguished; and *Glyphocyphus* belongs to the Upper-Greensand age.

With regard to the form *Progonechinus Eocenicus*, we have with some hesitation placed it amongst the Temnopleuridæ; its position in the family depends on the normal nature of the cavities which exist at the angles of the sutures. The ornamentation is totally different from any known genus, however.

With regard to the forms usually classified under the genus *Conoclypeus* by palæontologists, it must be remembered that Zittel ('Handbuch der Paläontologie,' vol. i. p. 515) has proved that *Conoclypeus conoideus*, Lamarck, has auricles and jaws, and that de Loriol has shown ('Echinides de l'Egypte,' p. 76 *et seq.*) that several other so called species of *Conoclypeus* have not jaws. The possession of jaws is generic, and it is accompanied by an absence of phyllodes, or doubling of the ambulacral pores near the peristome. On the other hand the absence of jaws and the presence of a phyllode take the species out of the genus *Conoclypeus*. Some of the species formerly classified with the genus *Conoclypeus* will now, on account of their having a phyllode, small bourrelets, and no jaws, be placed as a new genus, *Phylloclypeus*, de Loriol. Others are species of *Echinolampas* according to de Loriol, such, for instance, as *Conoclypeus Osiris*, Desor, from Egypt.

The new forms from Sind are readily distinguishable from the Egyptian types published by de Loriol, and from those described by d'Archiac and Haime from Sind.

Conoclypeus declivis is not without its alliances with *Conoclypeus subcampanæiformis*, Bittner, from the Eocene of the Istrio-Dalmatian area.

The portion of a test which shows a phyllode, on Plate XII, Fig. 8, came from a Conoclypeoid-looking test. But there are evidently additional or intercalated plates in the ambulacrum; and the pores penetrate through them, and are not simply in the line of the sutures. The specimen does not appear to belong to the genus *Echinolampas*; and we introduce it into de Loriol's new genus *Phylloclypeus*.

Probably *Phylloclypeus* will eventually be admitted to be a subgenus of *Echinolampas*. At present we associate it with the Echinolampinæ as a subfamily of Cassidulidæ.

The genus *Plesiolampas* has one species in the strata below the Trap, or in the *Cardita-Beaumonti* beds (*Plesiolampas elongata*, nobis); and there are five well-marked species in the Ranikot series. There are none in the higher horizon of the Khirthar series, nor are any species amongst the collections from Kach. There are no forms resembling any of the genus in the collections of d'Archiac and Haime, nor, in fact, in any others.

The numerous specimens in a good state of preservation and of different stages of growth have enabled us to give the minute details of the test in young and old specimens. There are certainly no jaws, and the phyllode is rudimentary. The inequality of the length of the poriferous zones is found in the young forms only; and the periproct becomes more totally inframarginal and longitudinally elongate with age.

The genus does not appear to be represented elsewhere than in Sind and (excepting the solitary species below the Trap) in the Ranikot series, of which it is characteristic.

MM. d'Archiac and Haime described a Cassidulid under the name of *Eurhodia Calderi*, but could give no satisfactory account of its geological horizon. The type in the collection of the Geological Society of London is not in good condition; and a specimen amongst those from the Ranikot group is in a moderately good state of preservation. But the collectors doubted the finding the specimen *in situ*; and on referring to the Khirthar series, which overlies the Ranikot, we find amongst the specimens derived from it numerous forms presenting the same kind of colour and mineralization. The form may or may not belong to the Ranikot series, and we enter it with doubt. It is a *Rhynchopygus*, however, and not a *Eurhodia*. We fail to see that the type of *Eurhodia Calderi* in the collection of the Geological Society is a *Eurhodia*; it is a *Rhynchopygus*.

The *Rhynchopygus pygmæus* might be at first sight taken for a young *R. Calderi*; but it is not so. It differs from the Egyptian forms described by de Loriol; and from its mineralization there is no doubt about its being a true Ranikot form.

A species of *Cassidulus* is amongst the Ranikot series; and the specimens show the beautiful floscelle and the posterior median line of cribriform structure. The posterior development of the test separates the species from all others of the genus.

The genus *Paralampas* recalls parts of the generic distinctions of both *Rhynchopygus* and *Catopygus.* The forms included within it are very perplexing in a classificatory sense; and, much as we regret having to devote a new generic title to them, we do not consider that they can be associated with any genus of the Cassidulids hitherto described. The remarkable peristome and its associated simple floscelle, the shape of the test, the shape and position of the periproct, the absence of the median pitted line on the concave actinal surface, the small petaloid ambulacral rosette with equal pores, and the homogeneous nature of the ornamentation of the actinal tuberculation are very distinctive.

Another Catopygian alliance is seen in the remarkable forms which are included in the genus *Neocatopygus.* The shape of the test, the small ambulacral rosette, the single series of the extrapetalous pores, and the character of the floscelle separate the genus very well from the *Catopygus* of Mesozoic age.

It is very remarkable that the only representative of the genus *Echinanthus* (Breynius) found in the Ranikot series should be a very anomalous one. The shape of the test, the highest part being eccentric in front, and the dwarfed anterior odd ambulacrum are very characteristic.

The genus *Eolampas* has an aborted anterior odd ambulacral petal, an anterior position of the apical system, and an open peristome with a very faint floscelle. It occurs also in the Khirthar series, which overlies the Ranikot group of strata. It might be said to represent the genus *Echinolampas* in the Ranikot series; but no true species of this genus are found therein, although they predominate in the higher groups.

The number of specimens of *Eurhodia Morrisi,* d'Archiac and Haime, sent to us renders it probable that it is a very common species. It is characteristic of the Ranikot series. The magnificent floscelle, the dimensions of the test, and the curious inequality of the breadth of the poriferous zones of the ambulacra cause the form to be very readily recognized. For such a large form the small size of the ambulacra is remarkable; but they are placed well forward. As the specimens now in the possession of the Geological Survey of India are far more perfect than those which were described by MM. d'Archiac and Haime, it has been necessary to redescribe the species to a certain extent.

There is no doubt about the presence of a fine *Prenaster* in the Ranikot series. The antero-lateral ambulacra have both of their poriferous zones developed; so the form cannot come within the genus *Agassizia.* The nearest alliance of the form is with *Prenaster Desori,* Cotteau; but there are good specific differences between them.

A well-defined species of *Hemiaster* and a very doubtful one are in the collection. The shape of *Hemiaster elongatus,* which is a very common fossil, is remarkable; and its structural details separate it from others. The presence of only two generative pores situated on mamelons, and the fact that the madreporic body passes backwards and separates the ocular plates, make the form to look much more modern than the Nummulitic.

There are two species of the genus *Linthia* in the Ranikot series. One is allied to *Linthia Arizensis*, d'Archiac, sp., which is found in the Nummulitic of Egypt and Europe; but it is well separated from the *Linthia* found in the strata beneath the Trap, in the *Cardita-Beaumonti* beds. The other *Linthia* is a large form not specifically distinguishable, on account of the weathering of the specimen. Its nearest ally appears to be *Linthia Delanouei*, de Loriol, from Egypt.

A *Schizaster* is found in the Ranikot series, the description and identification of which have given much trouble. The specimen is solitary and is crushed; but some parts of the structure remain in great perfection. As it is a very striking form, we have described it, more for the sake of field-geologists who may take up the study of the Ranikot series in detail, than for the sake of the advanced palæontologist. One of our difficulties was produced by the wretched condition of the type of *Schizaster Newboldi*, D'Archiac and Haime. It is really a worthless species. The form under consideration has some resemblance to *Schizaster Africanus*, de Loriol, from Egypt.

Finally, there is an ill-preserved specimen of the genus *Metalia*. It may be the *Brissopsis Sowerbyi*, d'Archiac and Haime.

There is no doubt that this fauna of Echinoidea is a remarkably isolated one. It has no form that can be satisfactorily and decidedly stated to be identical with any European or American species. The alliance with the Egyptian Nummulitic Echinoid fauna is of the slightest description. There are no species common to this fauna and that of the strata on the same area beneath the Trap which covers the *Cardita-Beaumonti* beds, and there are no species common to the Ranikot series and the Upper Cretaceous beds of Southern India.

Making due allowance for errors in collecting specimens, the community of species between the Ranikot and overlying Khirthar series is very small, and no form passes up to the Nari group.

The grouping of the genera of Echinoidea of the Ranikot series is interesting, and it becomes all the more important in the attempt to define the geological horizon of this great vertical mass of Nummulite-bearing beds, which, however, are clearly beneath the main Nummulitic limestone of the superincumbent and unconformable Khirthar series. In the Ranikot fauna there are 41 species and a variety; and in the whole of the Echinoidean fauna from the Nummulitic strata of Egypt de Loriol notices 42 species. In this corresponding number of species none are identical, and the affinities (of two) are very slight. The generic assemblage of the Ranikot series differs, moreover, from the Egyptian. It contains a greater number of regular Echini; and only the following genera are common to both areas—*Porocidaris*, *Conoclypeus*, *Rhynchopygus*, *Hemiaster*, *Linthia*, and *Schizaster*. The great mass of the characteristic genera of the Ranikot series are not found in the Egyptian area; and, *vice versâ*, the important genera of the Egyptian Nummulitic are not found in the Ranikot series, or are sparsely represented in species.

Thus the genera *Salenia*, *Cyphosoma*, *Acanthechinus*, the Temnopleuridæ, the genera *Eurypneustes* and *Æolopneustes*, *Phylloclypeus*, *Plesiolampas*, *Echinanthus*, *Eolampas*, *Paralampas*, *Cassidulus*, *Eurhodia*, *Neocatopygus*, *Prenaster*, and *Metalia* (in all 18 genera of the Ranikot series out of its 26 genera) are not found in Egypt.

The Egyptian fauna is rich in species of *Echinolampas* and *Macropneustes*, *Hemispatangus* and *Euspatangus*. It contains the well-known genera *Conoclypeus*, *Amblypygus*, *Orthopsis*, *Micropsis*, *Sismondia*, and *Echinocyamus*; and there is a fine group of Schizasters and Linthias. There are two Linthias in the Ranikot series and a Schizaster; but all the above-mentioned genera are absent.

The generic distribution in the two areas, although plainly Eocenic, is very different. The absence of the genera *Echinolampas* and *Amblypygus* in the Ranikot series is very suggestive, especially as they appear in the succeeding Khirthar group.

The position of the Egyptian beds, or the Mokattam series, which have yielded the Echinoidea is stated by de Loriol to be on the horizon of San Giovanni Ilarione in the Vicentin, and of the Eocene of the Canton de Schwytz. These are the equivalents of the Calcaire grossier of Paris. But the succession of beds in Egypt appears to be, from the results of the works of Fraas, Zittel, d'Archiac, and Delanoue as follows:—On the top, beds with *Ostrea flabellula*, and below it the shale containing the Echinoidea described by de Loriol. Still lower are beds with *Atruria ziczac*, and of the age of the London Clay. Zittel has discovered under the Mokattam series, which he considers Lower Nummulitic, a series which he calls the Libyan; and it includes the *Atruria-ziczac* horizon. It rests on Cretaceous sandstones.

Are the Ranikot beds of the same geological age as the Mokattam series, or do they belong to Zittel's inferior stage, which would seem to range through the age from the Chalk to the London Clay inclusive? The homotaxis of the genera of the Ranikot series is not that of the Mokattam age; and this last has greater affinities, so far as its distribution of genera is concerned, with the Khirthar strata above the Ranikot series.

The Fossil Corals of the Ranikot series were shown to belong to 50 species ('Fossil Corals and Alcyonaria of Western Sind,' Palæont. Indica, series xiv. p. 38), and that only 7 of these were identical with European species from the zones of *Nummulites planulatus* and *Cerithium giganteum*. It is a remarkable fact that the Nummulitic Echini of Kach have greater affinities with the Egyptian fauna than with that of Ranikot, and the genus *Echinolampas* predominates with *Macropneustes*.

Laube and Dames have given the data for comparing the fauna of Echinoidea of the Vicentin Eocene. In the lowest deposits of Monte Postale and Monte Spilecco there are two genera, *Cyclaster* and *Cœlopleurus*, and also *Echinolampas*, which are not found in the Ranikot, but which are in abundance in higher horizons in Sind. At San Giovanni Ilarione there are the genera *Cidaris*, *Porocidaris*, *Cyphosoma*, *Pyrina*, *Echinocyamus*, *Amblypygus*, *Nucleolites*, *Pygorhynchus*, *Ilariona*, *Echinolampas*, *Oviclypeus*, *Conoclypeus*, *Cyclaster*, *Linthia*, *Schizaster*, *Pericosmus*, *Prenaster*, *Metalia*, *Gualteria*, *Peripneustes*, and *Euspatangus*.

Bittner described some of the Echinoidea of the older tertiaries of Vicenza and Verona in 1880–1881[*], and mentions the genera *Cidaris* (*Leiocidaris*), *Leiopedina*, *Ceratomus*, *Cassidulus*, *Echinanthus*, *Pygorhynchus*, *Ilariona*, *Echinolampas*, *Conoclypeus*, *Hemiaster*, *Linthia*, *Schizaster*, *Pericosmus*, *Prenaster*, *Parabrissus*, *Toxobrissus*, *Peripneustes*, *Lovenia*.

The Eocene strata of Istria and Dalmatia have had their Echinoid fauna studied and admirably described and illustrated by Taramelli and Bittner[†]. The fauna is tabulated by Bittner, who finds the following genera represented:—*Cidaris* (*Leiocidaris*), *Porocidaris*, *Pseudodiadema*, *Cœlopleurus*, *Cyphosoma*, *Micropsis*, *Echinocyamus*, *Caratomus*, *Amblypygus*, *Nucleolites*, *Echinanthus*, *Pygorhynchus*, *Echinolampas*, *Conoclypeus*, *Cyclaster*, *Hemiaster*, *Linthia*, *Schizaster*, *Pericosmus*, *Prenaster*, *Gualteria*, *Macropneustes*, *Peripneustes*, *Euspatangus*.

The principal genera, or those affording the greatest number of species, are *Cidaris*, *Echinanthus*, *Echinolampas*, *Linthia*, and *Schizaster*. There are no less than twelve species of *Echinolampas*. This does not resemble the Ranikot fauna.

The Etage Montien (the inferior Eocene of Belgium) contains two species of *Cidaris*, *Goniopygus minor*, *Cassidulus elongatus*, *Echinanthus Corneti*, and *Linthia Houzeaui*. Above this horizon, in the Landenian, come *Holaster*, *Hemiaster*, and *Schizaster*, with *Ostrea bellovacina*, and still higher, in the Yprésien supérieur, with *Turbinolia sulcata* and *Nummulites planulatus*, the genera *Maretia*, *Schizaster*, *Scutellina*, and *Cidaris*. In the higher horizon with *Nummulites lævigata*, the genus *Echinolampas* comes in, with *Echinocyamus*, *Lenita*, and *Spatangus*.

In the London Clay the genera are *Cidaris*, *Echinus*, *Echinopsis*, *Cœlopleurus*, *Spatangus*, *Hemiaster*, *Euspatangus*, and *Schizaster*.

It is hopeless, after studying these details, to give the Ranikot series any definite equivalency. The indefinite Cretaceous facies of part of the Ranikot and sub-Trap faunas, and the absence of very distinctive Lower Eocene genera of European or African types in them, would seem to place the series lower than the Mokattam group and the fossiliferous Eocenes of Kach. At the same time the evidence given by the corals indicates a moderate alliance with the fauna of the lowest Nummulitic age of Europe and a possibly greater antiquity. It must be remembered that the Ranikot series is beneath the great development of Nummulitic limestone which occurs in the superincumbent and unconformable Khirthar series. It appears that there is some alliance between the Ranikot series of Echinoidea and those from the Cainozoic (Miocene ?) of Australia (Duncan, Quart. Journ. Geol. Soc. vol. xxxiii. p. 42); but it is of the slightest description. There is little to be said regarding the affinities of the Echinoidea of the Arrialoor or

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[*] Beiträge zur Pal. von Oesterreich-Ungarn (Wien, 1881), Bd. i. Heft 2.

[†] Taramelli, 'Atti del Reale Istituto Veneto,' 1873–74, t. iii. ser. 4, p. 951; Bittner, 'Beiträge sur Pal. von Oesterreich-Ungarn' (Wien, 1880), Bd. i. Heft 1.

Upper Chalk of the south of Hindostan and those of the deposits above the Cretaceous in Sind. Yet there is a slight Cretaceous facies in the Ranikot Echinoid fauna; but the palæontological break is still vast. From our present knowledge, then, the Ranikot series is the lowest in the Nummulitic group, and its fauna is a very special one. The series is older than the Kach, Egyptian, and Southern Alpine groups of Echinoid-bearing strata; and these are more on the horizon of the succeeding Khirthar series.

Position of the Fossil Echinoidea.

The species which were described in the first part of this Monograph, pages 7–20, were collected in strata containing *Cardita Beaumonti* and the Corals described in the 'Palæontologia Indica,' ser. xiv. 1880.

A trap covers the *Cardita-Beaumonti* strata; and hence the specimens have been occasionally stated to have come "from beneath the Trap." But it appears that a second trap (and possibly a third) exists in relation to these strata (see 'Memoirs of the Geological Survey of India,' vol. xvii. pt. 1, "The Geology of Western Sind," by W. T. Blanford, F.R.S., pages 129–134).

The fact that a great depth of strata, not of marine origin, overlies the *Cardita-Beaumonti* series, which in turn are overlain by the fossiliferous strata of the Ranikot series, suffices to distinguish the age and position of the two sets of Echinoidea.

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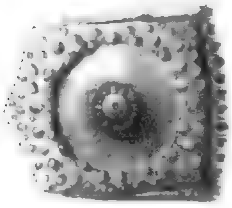
PLATE V.

Figure 1. CIDARIS, sp. (page 25). An interradial plate, magnified.
2. A section of a plate, magnified.
3. A portion of an ambulacrum, magnified.
4. PHYLLACANTHUS, sp. (page 28). Part of a test, natural size.
5. A plate, magnified.
6. CIDARIS VERNEUILI, D'Archiac and Haime (page 26). A plate, natural size.
7. A plate, magnified.
8. A section of a plate.
9. PHYLLACANTHUS RANIKOTI, Duncan and Sladen (page 27). The plates, natural size.
10. An interradial plate, with a portion of an ambulacrum, magnified.
11. PHYLLACANTHUS SINDENSIS, Duncan and Sladen (page 27). A part of the test, natural size.
12. A portion, magnified.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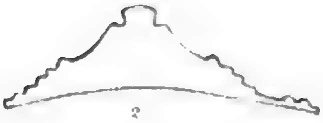
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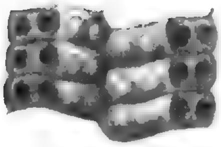
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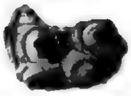
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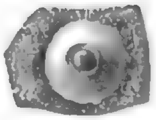
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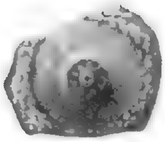
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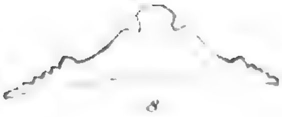
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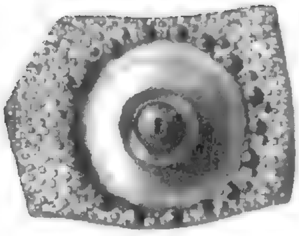
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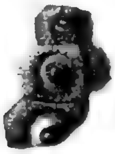
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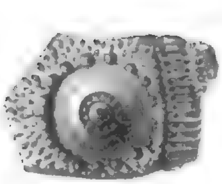
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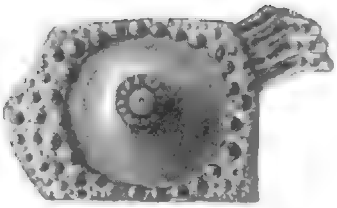
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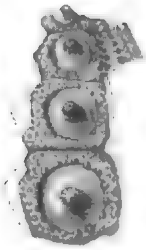
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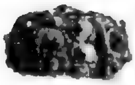
Duncan & Sladen del. A. S. Foord lith.

Mintern Bros. imp.

Fossil Echinoidea from Sind.
Ranikot Series

PLATE VI.

Figure 1. **Salenia Blanfordi**, Duncan and Sladen (page 29). The test, side view, natural size.
2. The apical system and upper surface of the test, magnified.
3. A larger specimen showing the actinal surface, slightly magnified.
4. The abactinal surface, magnified.
5. A specimen, natural size.
6. A portion of an ambulacrum, magnified.
7. Three plates in the interradium with tubercles, magnified.
8. A young specimen, magnified.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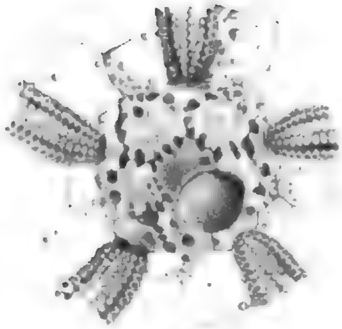
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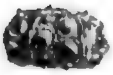
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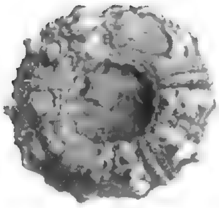
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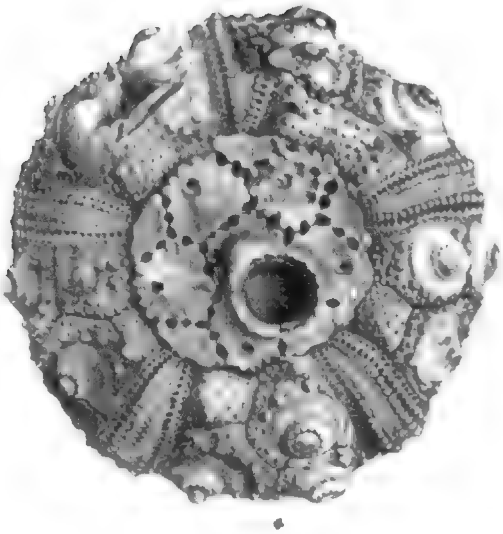
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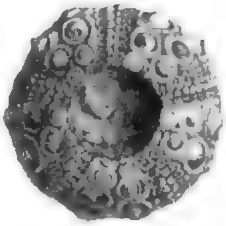
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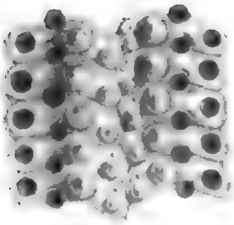
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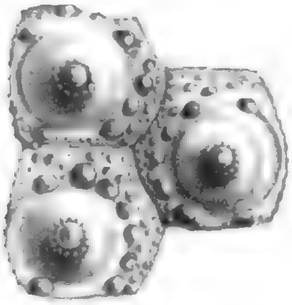
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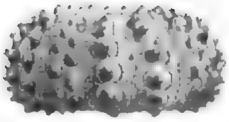
Duncan & Sladen, del. A S Foord, lith.

Mintern Bros imp.

Fossil Echinoidea from Sind
Ranikot Series

PLATE VII.

Figure 1. Cyphosoma abnormale, Duncan and Sladen (page 32). The side view of a large specimen, natural size.
2. The abactinal surface, slightly magnified.
3. A small specimen, magnified 2 diameters.
4. An ambulacrum of the large specimen (Fig. 1), magnified.
5. Interradial tubercles and pores of the smaller specimen (Figure 3), near the ambitus, magnified.
6. The poriferous zone and the adjoining ambulacral and interradial plates near the peristome of the larger specimen, magnified.
7. An interradial tubercle and plate of the large specimen, magnified.
8. A young specimen, natural size.
9. The poriferous zone and adjoining ambulacral and interradial plates of Figure 8, magnified.



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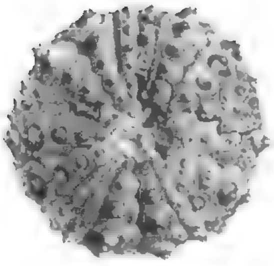

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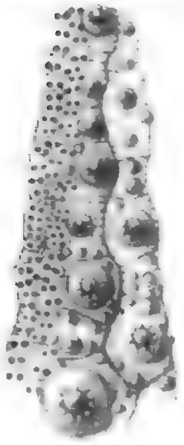

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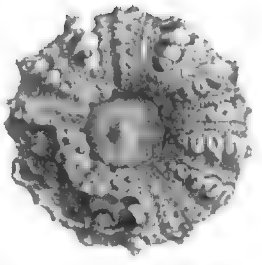

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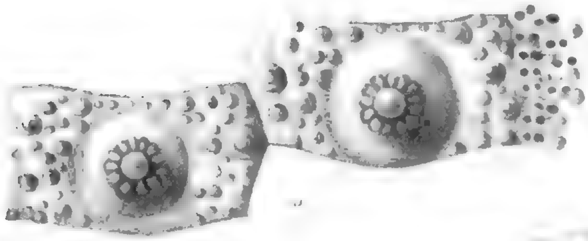

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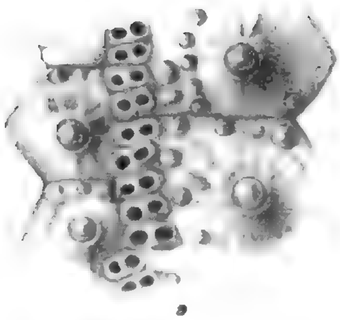

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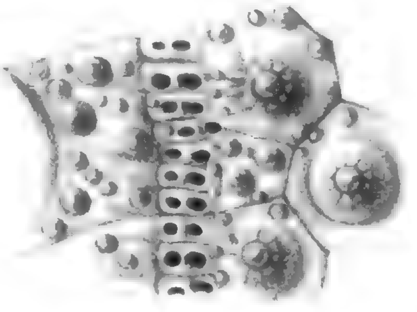

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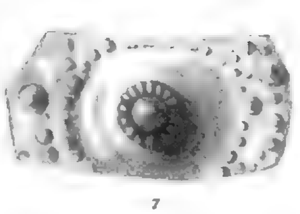

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Duncan & Sladen del. A. S. Foord lith.

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Fossil Echinoidea from Sind.

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PLATE VIII.

Figure 1. ACANTHECHINUS NODULOSUS, Duncan and Sladen (page 34). The test, natural size.
2. Ambulacral and interradial plates near the ambitus, magnified.
3. A primary tubercle, magnified.
4. EURYPNEUSTES GRANDIS, Duncan and Sladen (page 46). Fragment of the test, natural size.
5. Ambulacral and interambulacral plates, magnified.
6. ÆOLOPNEUSTES DE LORIOLI, Duncan and Sladen (page 48). Actinal view of the specimen, natural size.
7. Outline of the profile of the test.
8. Ambulacral and interambulacral plates, magnified.
9. A portion near the peristome, showing the cuts, magnified.

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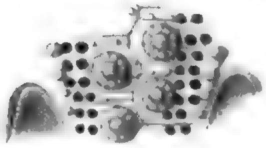

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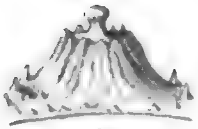

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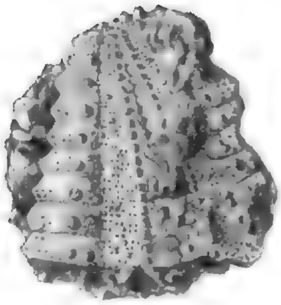

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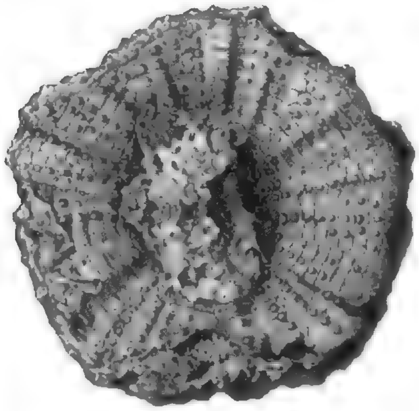

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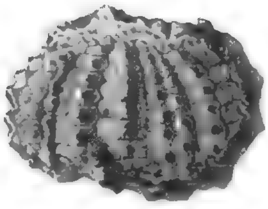

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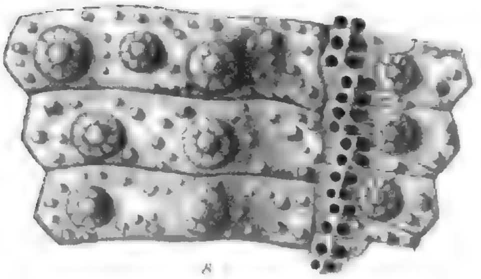

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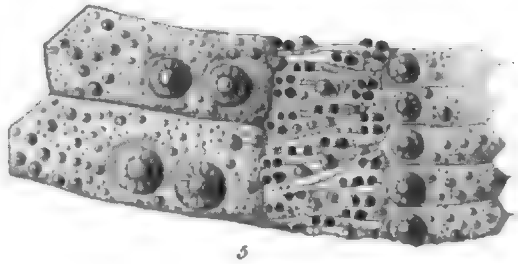

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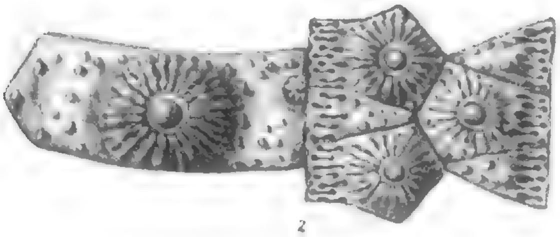

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Fossil Echinoidea from Sind.
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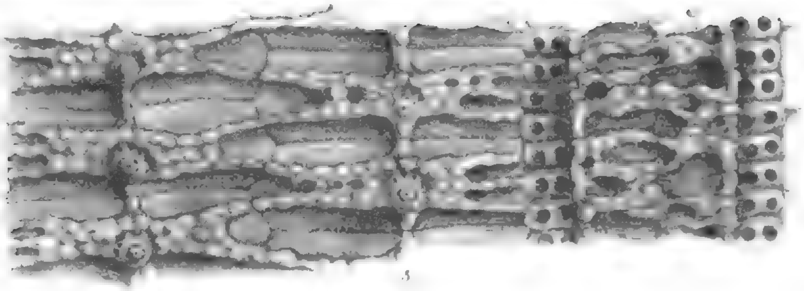
PLATE IX.

Figure 1. **Dictyopleurus ziczac**, Duncan and Sladen (page 38), natural size.
2. The apical system, magnified.
3. Part of an ambulacrum and interambulacrum, magnified.
4. **Dictyopleurus Haimei**, Duncan and Sladen (page 39), natural size.
5. Part of an ambulacrum and interambulacrum, magnified.
6. **Arachniopleurus reticulatus**, Duncan and Sladen (page 42), natural size.
7. Part of an ambulacrum and interambulacrum, magnified.
8. Some ridges near the apical system, magnified.



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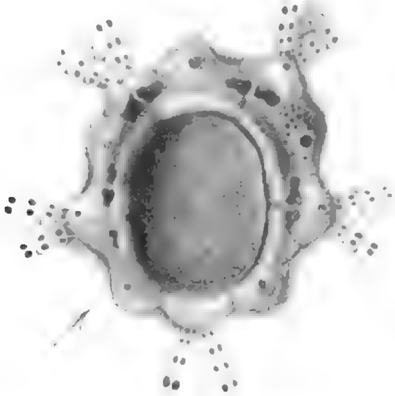

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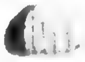

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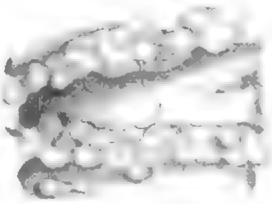

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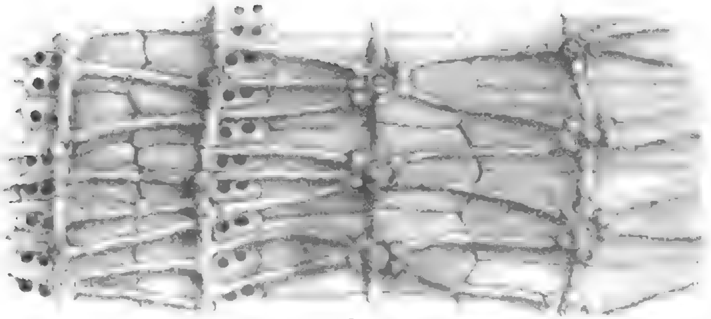

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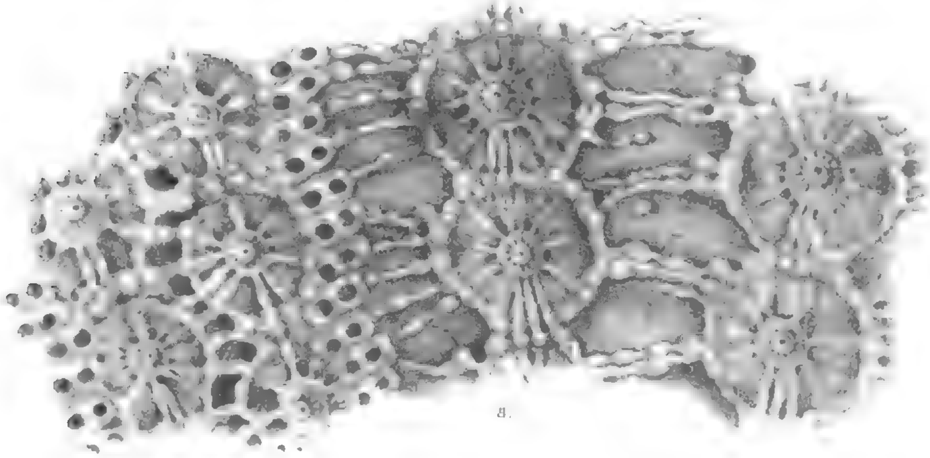

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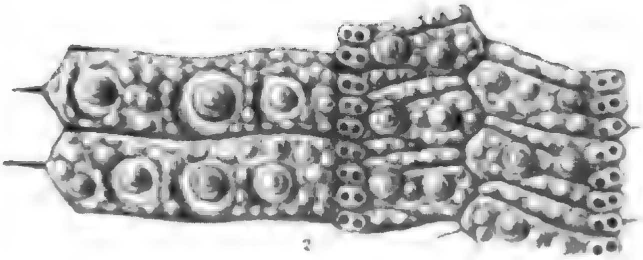
PLATE X.

Figure 1. **Progonechinus Eocenicus**, Duncan and Sladen (page 48), natural size.
2. An ambulacrum and part of an interradium, magnified.
3. A portion of the test near the actinostome, magnified.
4. A side view of the test, natural size.
5. **Dictyopleurus d'Archiaci**, Duncan and Sladen (page 41), natural size.
6. An ambulacrum and part of an interradium, magnified.
7. A weathered specimen, natural size.
8. The same, part of an ambulacrum and interradium, magnified.
9. A spine of a species of **Cidaris** (page 50), natural size.
10. A portion, magnified.
11. A spine of a species of **Cidaris** (page 50), natural size.
12. A portion, magnified.
13. A small spine of a **Cidaris** (page 50), natural size.
14. The ring around the cavity for the tubercle, showing incomplete crenulation, magnified.



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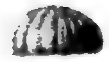

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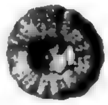

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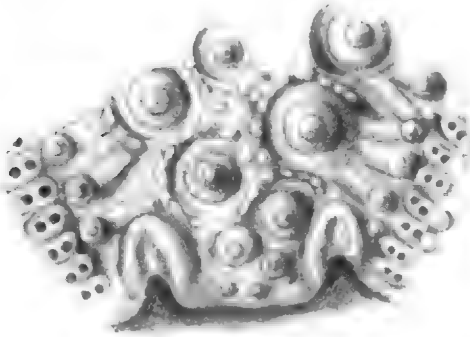

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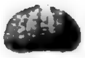

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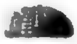

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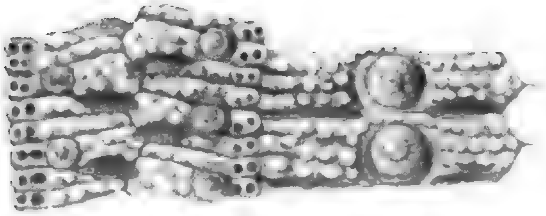

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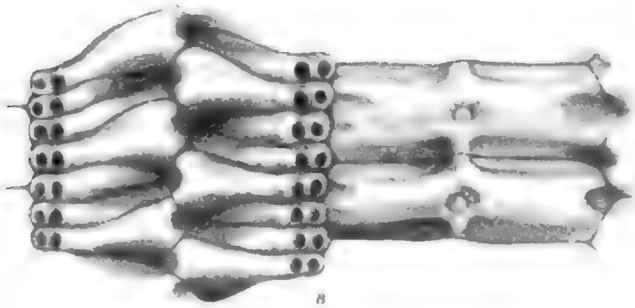

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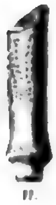

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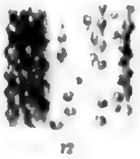

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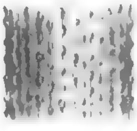

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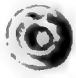

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PLATE XI.

Figures 1–11. Spines of Cidaridæ, genus CIDARIS, natural size. Figs. 5*, 10*, and 11*: Ornamentation, magnified. (Page 50.)

12. A spine of POROCIDARIS, natural size. (Page 50.)
13. The same, magnified.
14–23. Spines of PHYLLACANTHUS, natural size. Fig. 16*: Ornamentation, magnified. (Page 50.)

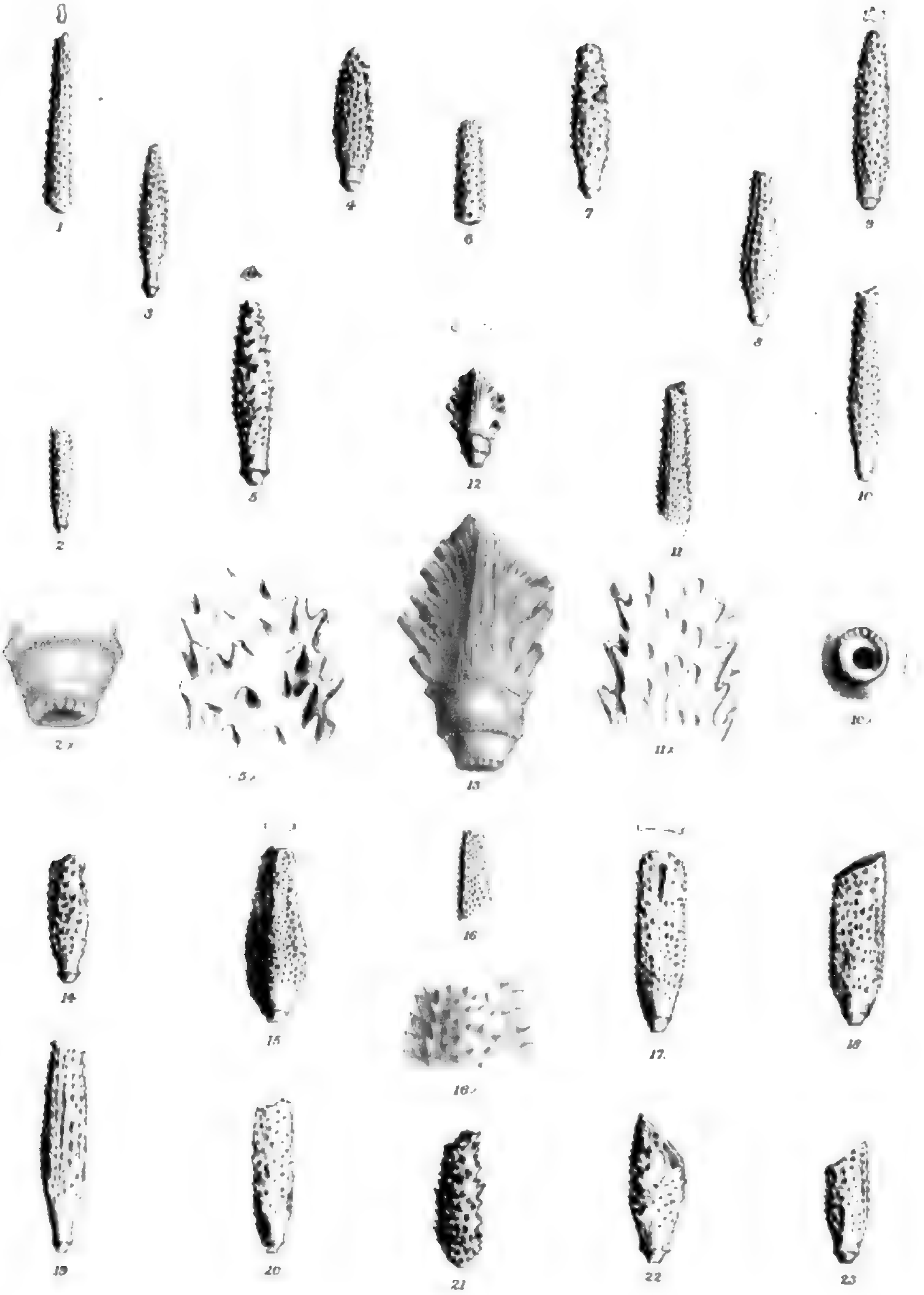
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PLATE XII.

Figure 1. CONOCLYPEUS SINDENSIS, Duncan and Sladen (page 51). The test, from below, natural size.

2. An end of an ambulacrum, slightly magnified.
3. The ornamentation of the test, magnified.
4. Part of an ambulacrum, high up, magnified.
5. A specimen of a CONOCLYPEUS (?) (page 52), side view, natural size.
6. Its periproct, natural size.
7. CONOCLYPEUS DECLIVIS, Duncan and Sladen (page 53). The test, natural size.
8. PHYLLOCLYPEUS (De Loriol's genus), species unknown (page 54). Phyllode, magnified.

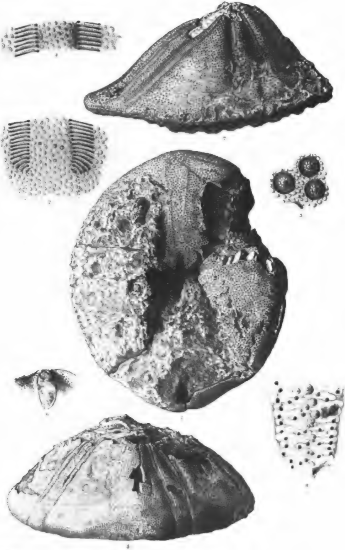

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PLATE XIII.

Figure 1. **PLESIOLAMPAS ROSTRATA**, Duncan and Sladen (page 61). The abactinal surface.
2. The side view.
3. The periproct, natural size.
4. **PLESIOLAMPAS PLACENTA**, Duncan and Sladen (page 54). Actinal surface.
5. Another specimen, abactinal surface.
6. Part of an ambulacrum, magnified.
7. The peristome, slightly magnified.
8. The peristomial margin, with an ambulacrum and faint bourrelets, magnified.
9. The longitudinal outline.
10. **PLESIOLAMPAS POLYGONALIS**, Duncan and Sladen (page 61). The abactinal surface.
11. The longitudinal outline.

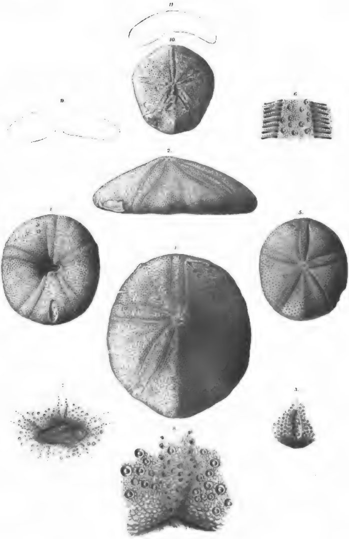
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PLATE XIV.

Figure 1. PLESIOLAMPAS PLACENTA, Duncan and Sladen (page 54). The rudimentary phyllode, magnified.

2. PLESIOLAMPAS PRÆLONGA, Duncan and Sladen (page 56). Actinal aspect of the test, natural size.

3. Apical disk and part of the surrounding portion of the abactinal surface, magnified. Also a portion of the poriferous zone, more highly magnified.

4. PLESIOLAMPAS OVALIS, Duncan and Sladen (page 58). Actinal aspect of the test, natural size.

5. Portion of the median granular band leading from the peristome to the periproct, magnified.

6. Outline of the longitudinal profile of the test.

7. Abactinal aspect of another specimen, natural size.

8. Apical disk and portion of the abactinal surface of another specimen, magnified.

9. Abactinal aspect of the test of a young specimen, natural size.

10. Actinal aspect of the same, natural size.

11. Abactinal aspect of a young specimen, natural size.

12. Apical disk and surrounding portion of the abactinal surface of the same specimen, magnified.

13. Outline of the longitudinal profile of the same specimen, natural size.

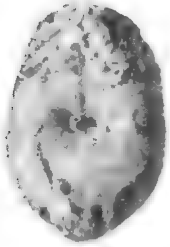
14. Actinal aspect of the test of a very young specimen, natural size.

15. Outline of the longitudinal profile of the same specimen, natural size.

16. Abactinal view of the test of the same specimen, natural size.

17. Peristome of a specimen one inch in length, magnified.

18. Apical disk and surrounding portion of the abactinal surface of the test of the same specimen, magnified.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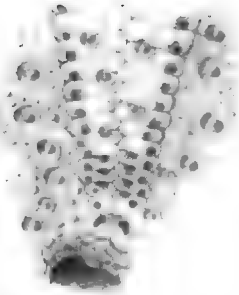
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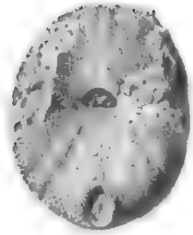
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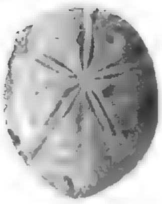
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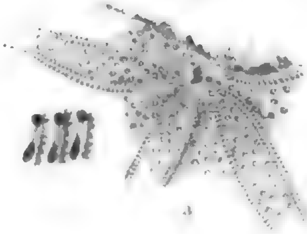
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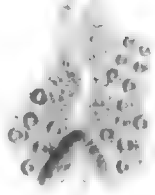
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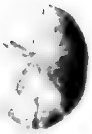
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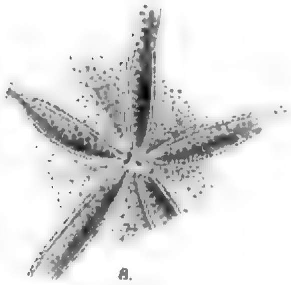
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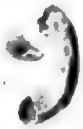
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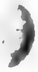
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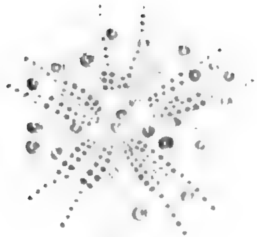
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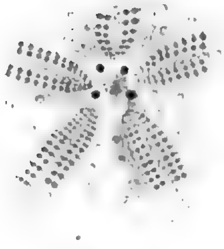
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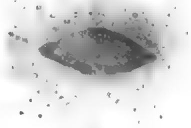
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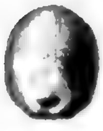
PLATE XV.

Figure 1. Rhynchopygus Calderi, d'Archiac and Haime, sp. (page 67). Side view, natural size.

2. From behind, natural size.
3. The odd ambulacrum, slightly magnified.
4. The pitted structure of the actinal median area, magnified.
5. Rhynchopygus pygmæus, Duncan and Sladen (page 68). The test, from above, natural size.
6. Part of the phyllode and pitted structure, magnified.
7. Cassidulus ellipticus, Duncan and Sladen (page 65). The test, from above, natural size.
8. The transverse section, natural size.
9. The floscelle and ornamentation, magnified.
10. The ornamentation of part of an ambulacrum.
11. Paralampas pileus, Duncan and Sladen (page 73). The side view of the test, natural size.
12. The posterior view, natural size.
13. The marginal outline, from the actinal side.
14. The abactinal area, magnified.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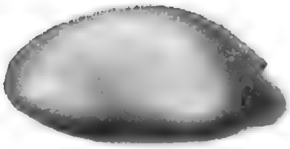
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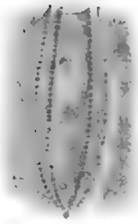
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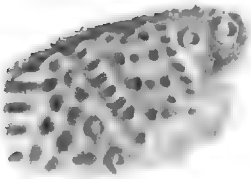
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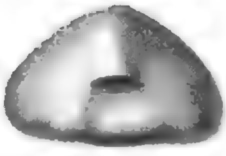
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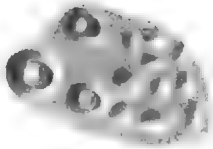
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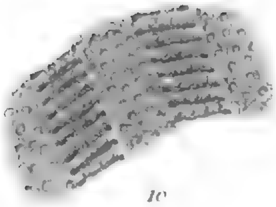
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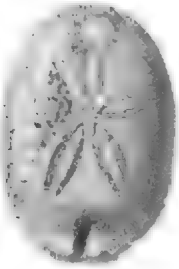
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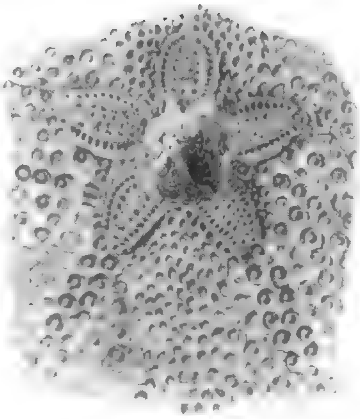
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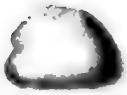
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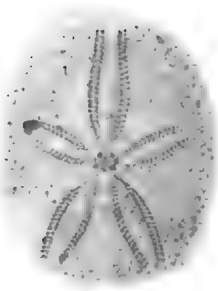
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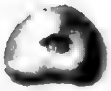
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Duncan & Sladen dir. A. Gawan lith.

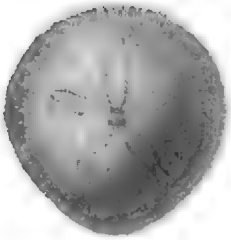
Mintern Bros imp.

Fossil Echinoidea from Sind
Ranikot Series

PLATE XVI.

Figure 1. Neocatopygus rotundus, Duncan and Sladen (page 76). The test, from above, natural size.

2. The test, from below, natural size.
3. The floscelle and peristome, magnified.
4. A side view of the test, natural size.
5. The posterior view, magnified.
6. The transverse outline.
7. The apical system, magnified.
8. A small specimen, from above.
9. The ornamentation, magnified.
10. Part of an ambulacrum, magnified.



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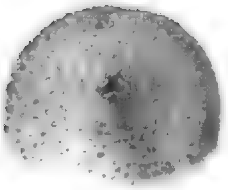

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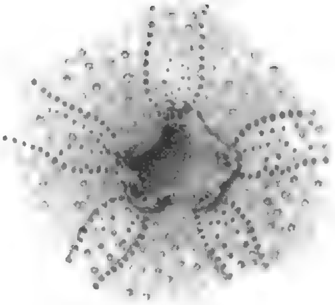

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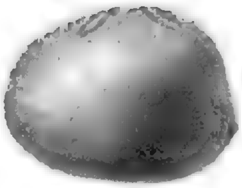

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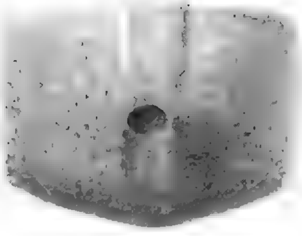

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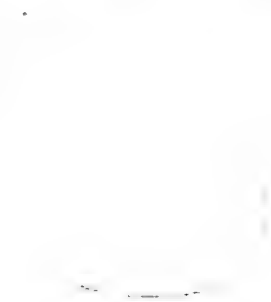

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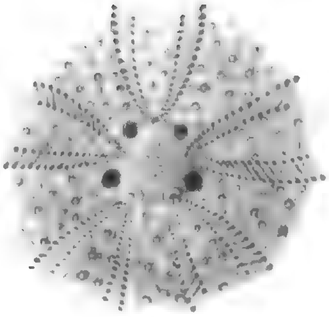

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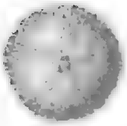

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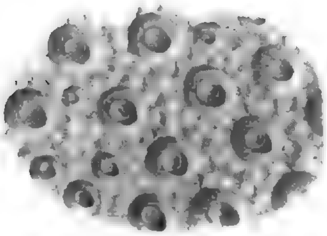

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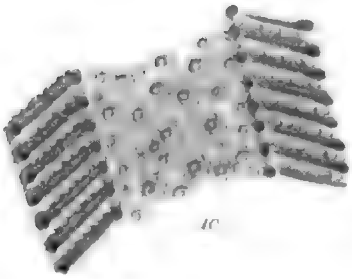

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Duncan & Sladen dir. A. Dawson lith.

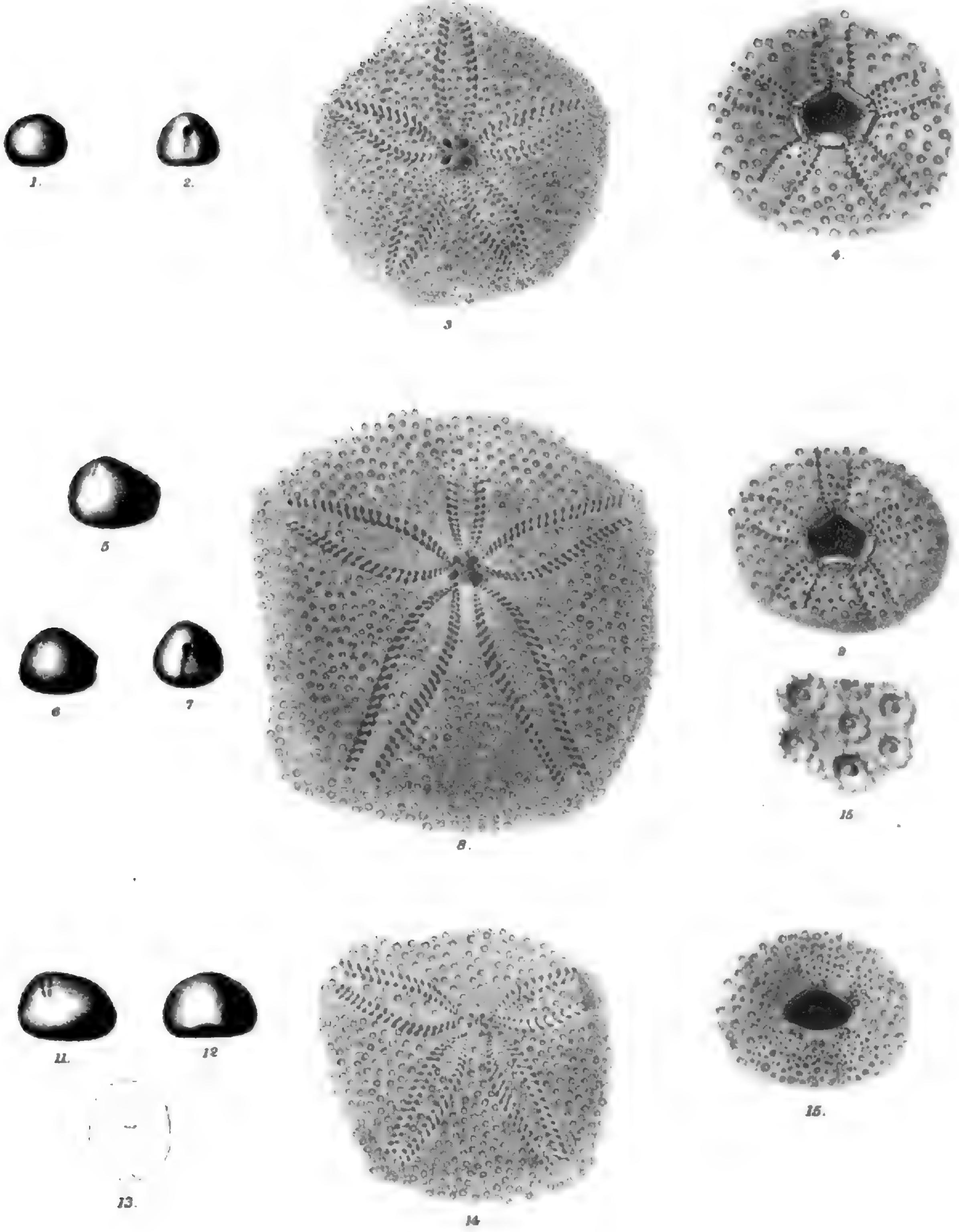
Mintern Bros. imp.

Fossil Echinoidea from Sind.
Ranikot Series

PLATE XVII.

Figure 1. PARALAMPAS MINOR, Duncan and Sladen (page 74). View from the side, natural size.
2. View from behind, natural size.
3. The apical system and petals, magnified.
4. The peristome, magnified.
5. ECHINANTHUS ENORMIS, Duncan and Sladen (page 64). A large specimen, side view, natural size.
6. A smaller specimen (the type), side view, natural size.
7. The same from behind, natural size.
8. The apical region, magnified.
9. The peristome, magnified.
10. Ornamentation, magnified.
11. EOLAMPAS ANTECURSOR, Duncan and Sladen (page 62). The side view, natural size.
12. From behind, natural size.
13. Outline of actinal surface, natural size.
14. The apical system and petals, magnified.
15. The peristome, magnified.

Geol. Survey of India. Plate XVII.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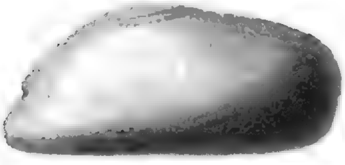
Duncan & Sladen dir. A Gasman lith.

Mintern Bros. imp.

Fossil Echinoidea from Sind.
Ranikot Series

PLATE XVIII.

Figure 1. **Eurhodia Morrisii**, D'Archiac and Haime (page 70). The test, from above, natural size.
2. Side view, natural size.
3. Transverse outline.
4. Actinal surface, natural size.
5. Apical system, magnified.
6. A portion of an ambulacrum, magnified.
7. The peristome and its ornamentation, magnified.



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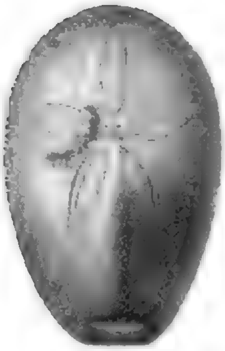

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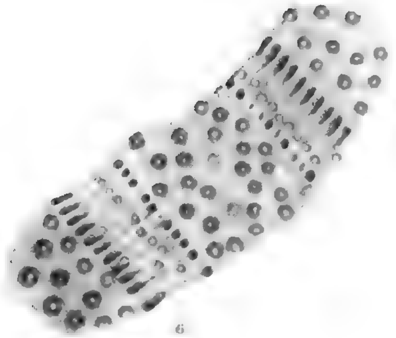

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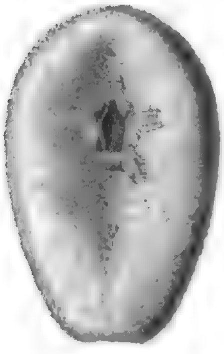

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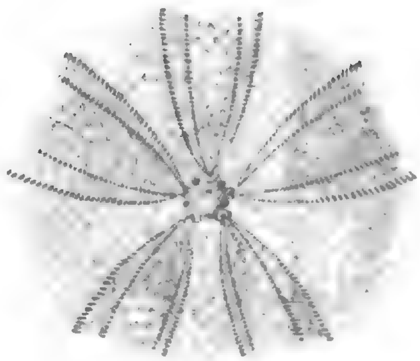

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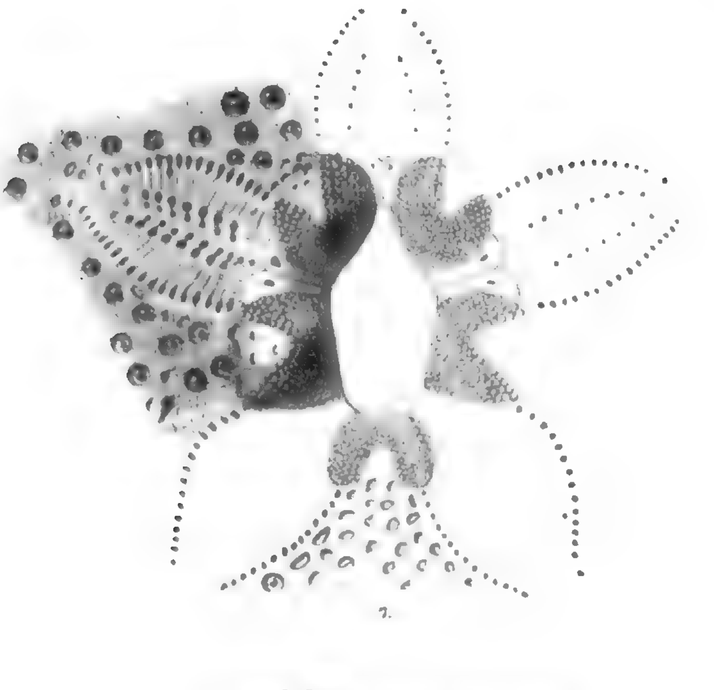

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Duncan & Sladen dir. A. Gowan lith.

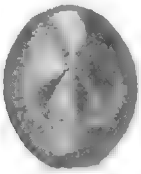
Mintern Bros imp.

Fossil Echinoidea from Sind.

Ranikot Series

PLATE XIX.

Figure 1. **Prenaster oviformis**, Duncan and Sladen (page 90). View from above, natural size.
2. Actinal surface, natural size.
3. Side view, natural size.
4. Posterior view, natural size.
5. Part of the odd anterior ambulacrum and ornamentation, magnified.
6. Part of an antero-lateral ambulacrum, magnified.
7. **Hemiaster elongatus**, Duncan and Sladen (page 78). The test, from above, natural size.
8. Actinal surface, natural size.
9. The apical system, magnified.
10. Outline of side view of a specimen, natural size.
11. Part of the anterior ambulacrum, magnified.
12.
13. } Outlines of the test of small specimens, from above, natural size.
14.
15. The test, from behind, natural size.



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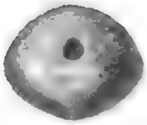

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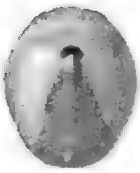

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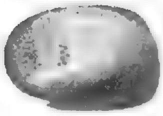

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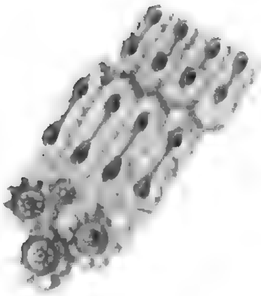

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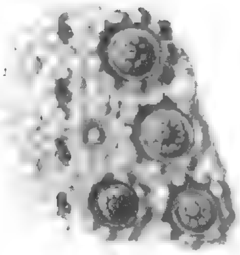

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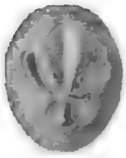

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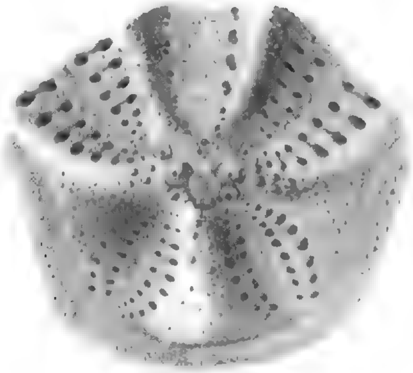

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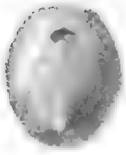

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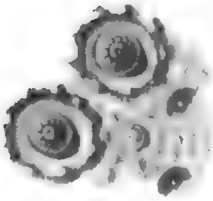

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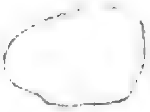

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Duncan & Sladen dir. A. Gowan lith. Mintern Bros. imp.

Fossil Echinoidea from Sind.
Ranikot Series

PLATE XX.

Figure 1. LINTHIA INDICA, Duncan and Sladen, variety (page 82). Actinal view, natural size.
2. Side view, natural size. Specimen rather crushed.
2*. Outline of test, natural size.
3. Apical system, magnified.
4. LINTHIA INDICA, Duncan and Sladen, variety (page 82). Side view, natural size.
5. LINTHIA INDICA. Abactinal view, natural size.
6. Posterior view, natural size.
7. Young form. Side view, natural size.
8. Posterior view, natural size.
9. LINTHIA, sp. (page 85). Abactinal surface, natural size.
10. SCHIZASTER ALVEOLATUS, Duncan and Sladen (page 87). From above, natural size.
11. Posterior view, natural size.
12. Ornamentation near the ambulacra, magnified.
13. Antero-lateral petal, magnified, showing fasciole.
14. Apical system of a specimen of a SCHIZASTER from Kach, magnified ; but it is probable that it is not of the same species as the above.

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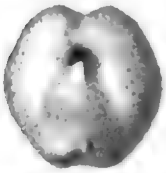

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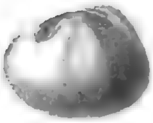

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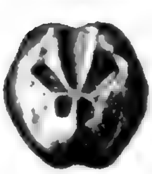

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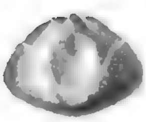

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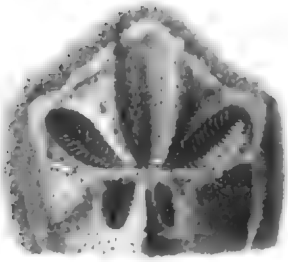

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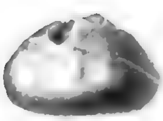

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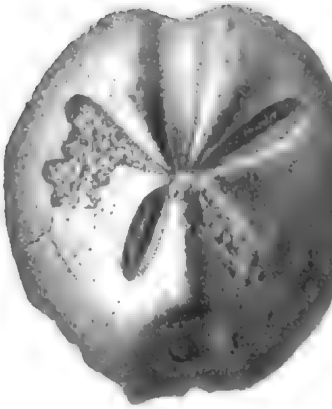

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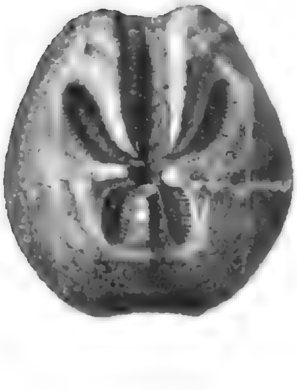

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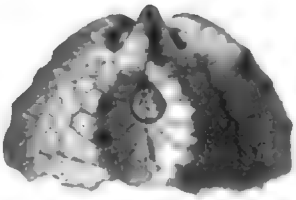

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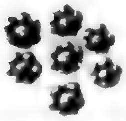

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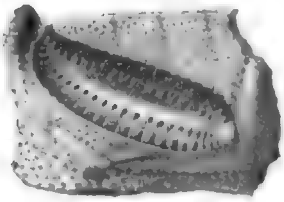

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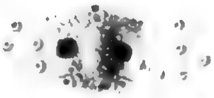

Duncan & Sladen del. A. Gawan lith.

Mintern Bros. imp.

Fossil Echinoidea from Sind.
Ranikot Series.

MEMOIRS
OF THE
GEOLOGICAL SURVEY OF INDIA.

Palæontologia Indica,

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING
THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL.

TERTIARY AND UPPER CRETACEOUS FOSSILS OF WESTERN SIND.
Ser. XIV.

Vol. I. 3. THE FOSSIL ECHINOIDEA.
Fasciculus III. THE FOSSIL ECHINOIDEA FROM THE KHIRTHAR SERIES OF NUMMULITIC STRATA IN WESTERN SIND.

WITH 18 PLATES.

BY

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A DESCRIPTION

OF THE

FOSSIL ECHINOIDEA

OF

WESTERN SIND.

Fasciculus 3.—THE KHIRTHAR SERIES.

I. *Introductory Remarks on the Khirthar Series.*

The Khirthar series of strata take their name from the great frontier range of hills which extends along the western boundary of the province of Sind as far south as lat. 26° 15′, and of which they form the crest throughout, as well as all the higher portions of the Laki range, of the Bhit and Badhra ranges south-west of Manchhar Lake, and of several smaller ridges[*]. This formation represents an aggregate thickness of about 9000 feet, the upper 3000 feet of which are a compact massive Nummulitic limestone, the underlying portion consisting of shales and sandstones. The lower beds are unfossiliferous, and pass without stratigraphical unconformity into the underlying Ranikot series. In like manner the Nari series of strata rest conformably upon the Khirthar.

The character and relative position of the Khirthar deposits have been briefly referred to in the Introductory part of Fasciculus 1 of this work, and diagrammatic sections showing the superposition of strata are given on page 6. The following extracts from the valuable memoir by Mr. W. T. Blanford, F.R.S.[†], will be of interest to the student of the fossil remains obtained from these strata, which form the subject of the present Fasciculus.

"The colour" of the massive limestone "is usually pale, either white or grey, sometimes, but less frequently, dark grey; the texture varies from hard, close, and homogeneous, breaking with a conchoidal fracture, to soft, coarse, and open. Ordinarily, the Nummulitic limestone is tolerably compact but not crystalline, and chiefly composed of *Foraminifera*, especially *Nummulites*, which are fragmentary; corals, sea-urchins, and molluscs also abound, but the two latter very frequently only weather out as casts.

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[*] Memoirs Geol. Surv. India, vol. xvii. p. 45.

[†] Geology of Western Sind (Mem. Geol. Surv. India, vol. xvii.).

"Throughout Northern Sind, except near Rohri, no beds are seen beneath the Khirthar limestone, and the rocks which crop out west of the Sind frontier from beneath the main limestone-band have already been described. The remarkable range of low hills surrounded by Indus alluvium, and extending for more than forty miles south from Rohri, consists of Nummulitic limestone, having a low dip to the westward; and beneath the limestone forming the eastern scarp of the hills, on the edge of the alluvial plain, a considerable thickness of pale-green gypseous clays is exposed, with a few bands of impure dark limestone and calcareous shale. No *Foraminifera* have been found in these clays, although *Nummulites* abound in the limestone immediately overlying; several species of Mollusca occur, but none are characteristic; and it is far from clear whether the green clays and their associates are merely thick bands intercalated in the limestone, or whether they belong to a lower group. Probably these argillaceous beds of the Rohri hills represent some of the marls, shales, and clays forming the lower portion of the upper Khirthar group on the Gáj river.

"The Nummulitic limestone of the Rohri hills is softer and whiter than that of the Khirthar range, a difference doubtless due to the much smaller amount of disturbance that the rocks have undergone in the former instance. A somewhat similar but greater difference has been shown to exist between the Nummulitic limestone of the Salt Range and that of the Himalayas in the Punjab.

"In some places west of Kotri, a band of argillaceous and ferruginous rock is found close to the base of the Khirthar group. This rock weathers into laterite; it is mainly composed of brown hæmatite, and appears to be found over a considerable area near Kotri and Jhirak. It is impossible to avoid suggesting its identity with the ferruginous lateritic bed found in a similar position in Guzerat, Cutch, the Salt Range, and the Sub-Himalayan region.

"In the Laki range the Nummulitic limestone rests unconformably on the Ranikot group. The Khirthar group here cannot be more than 500 or 600 feet thick, and consists entirely of limestone. To the south-east, towards Kotri and Tatta, there is no unconformity between the Ranikot and Khirthar groups, but, on the contrary, there is an almost complete passage between the two, and the limestone of the latter becomes much split up and intercalated with shales and sandy beds. This is even more the case further to the south-east in Cutch, where the whole group consists of comparatively thin beds of limestone, interstratified with shales. To the south-west, near the Habb river, the massive limestone dies out altogether; and although it is well developed in the southernmost extremity of the Khirthar range, near Karchát, about 50 miles south of Sehwán, it disappears within a distance of 25 miles, and in the ranges on the Habb river is entirely replaced by shaly limestone, shales, and thin beds of sandstone. Some rather massive beds of Nummulitiferous dark-grey limestone, very different in character from the pale-coloured Khirthar limestone, are found west of the Habb, but their precise position in the series is not known; and the rocks appearing from beneath the Nari group, in the place of the Khirthar limestone, consist of shales and sandstones, with some calcareous bands abounding in Nummulites, and closely resembling, both in character and in the species of *Foraminifera* they contain, the Nummulitic shales beneath the massive limestone on the Gáj river. It is not known to what extent the typical Khirthar limestone is developed in Baluchistan; around Kelát, to the northward, this band appears to be extensively exposed, but to the westward, near Gwádar, the rocks supposed to represent the older Tertiary beds consist of an immense thickness of shales, shaly sandstones, and unfossiliferous calcareous bands, resembling the lower Khirthars of the Gáj and the beds of the Habb valley, and limestones with Nummulites are of frequent and local occurrence. It is thus evident that the Khirthar limestone, although it is so conspicuous in most parts of Sind, and although it attains a considerable thickness, is not by any means universally distributed."

The character of the organic remains of the Khirthar series is unquestionably Eocene, and the various faunæ are distinctly comparable with those homotaxially related to them in other parts of the world. Foraminifera are richly represented, and Mollusca are numerous. Out of 17 species of Foraminifera mentioned in Mr. Fedden's list[*], 4 species pass down into the Ranikot series, the remainder being peculiar to the Khirthar, and none pass up into the Nari.

Out of 43 species of Mollusca[†] (omitting those whose determination was doubtful), 14 species pass down into the Ranikot, 2 of these extending into the transition beds; 3 species pass up into the Nari, these three being also amongst those Khirthar forms which are found in the Ranikot; and 1 species passes up into the Gáj which has not yet been found in the Nari.

The Coral fauna[‡] is represented by a comparatively limited number of forms. Out of 16 species accredited to this formation, 10 are from beds so high in the series that it is uncertain whether they may not belong to the more recent Nari series. Of the remaining 6 species, 2 are identical with fossil forms from European strata.

The Echinoderm fauna is rich both in number of species and of individuals. 70 species and varieties of Echinoidea are noticed in the following pages. The character of the Echinoidean fauna of the Khirthar series is, like that of the Ranikot series, remarkably isolated. 63 species and varieties belong unquestionably to these strata exclusively—that is to say, they have not yet been found in other geological horizons. Four of the remaining 7 species are characteristic Khirthar forms, but were included in the collection of Echinoids from the Ranikot series, to which formation they were also ascribed. That the specimens in question really belonged to the Ranikot age is very doubtful; and in a future page we shall discuss the evidence upon which we consider it highly probable that they were derived from Khirthar beds. Three other species, of which only single and fragmentary specimens are included in the collection, have evidently, from the nature of their matrix, been assigned by accident to the Khirthar formation; they are also characteristic fossils in higher beds. None of the Khirthar forms have as yet been found in the Nari series.

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[*] Memoirs Geol. Surv. India, vol. xvii. p. 197 *et seq.*

[†] *Op. cit.* p. 201.

[‡] P. Martin Duncan, "Fossil Corals of Sind," Pal. Ind. ser. xiv. (1880).

The relations of the Khirthar Echinoidea with those from other homotaxial areas are representative but not identical: the general facies of the fauna and its peculiarities will be remarked on in the sequel.

Owing to the nature of the matrix and the accidents and difficulties of exposure, the Khirthar fossils are not preserved in such beauty and perfection as is frequently the case in Tertiary specimens from higher beds. Many are more or less broken or obscured by matrix, and in some instances out of a dozen examples none are absolutely perfect. These circumstances have obviously increased the difficulties of determination. Out of the 70 species and varieties mentioned in this Fasciculus, there are 10 forms to which we have refrained from assigning, on the above grounds, any specific name. In most cases they are isolated specimens, and all that can be said definitely about them is, that they differ from the other forms recorded. Their state of preservation is such as to render a useful description impossible; and we have consequently considered that the interests of science are best served by simply placing their occurrence on record until better material is available. Wherever practicable, a drawing of the specimen has been given, for the assistance of the labours of the Geological Survey.

II. *List of the Fossil Echinoidea from the Khirthar Series.*

Order ECHINOIDEA ENDOCYCLICA.

Family CIDARIDÆ.

Genus CIDARIS, *Klein*, 1734.

Subgenus LEIOCIDARIS, *Desor*, 1854.

Leiocidaris canaliculata, *Duncan & Sladen*: p. 109.

Genus POROCIDARIS, *Desor*, 1854.

Porocidaris anomala, *Duncan & Sladen*: p. 113.

Family GLYPHOSTOMATA.

Subfamily DIADEMATIDÆ.

Genus CYPHOSOMA, *Agassiz*, 1840.

Cyphosoma macrostoma, *Duncan & Sladen*: p. 116.
—— undatum, *Duncan & Sladen*: p. 117.

Genus MICROPSIS, *Cotteau*, 1856.

Micropsis venustula, *Duncan & Sladen*: p. 119.

Subfamily TEMNOPLEURIDÆ.

Genus TEMNECHINUS, *Forbes*, 1852.

*Temnechinus Rousseaui, *d'Archiac*, sp.: p. 122.

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* A single example, evidently included accidentally in the Khirthar Collection. It came from a much higher horizon.

Order ECHINOIDEA EXOCYCLICA.

Suborder GNATHOSTOMATA.

Family CONOCLYPEIDÆ.

Genus CONOCLYPEUS, *Agassiz*, 1840.

Conoclypeus alveolatus, *Duncan & Sladen*: p. 124.
—— pinguis, *Duncan & Sladen*: p. 126.
—— rostratus, *Duncan & Sladen*: p. 128.
—— galerus, *Duncan & Sladen*: p. 129.

Family CLYPEASTRIDÆ.

Subfamily EUCLYPEASTRIDÆ.

Genus ECHINOCYAMUS, *van Phelsum*, 1774.

Echinocyamus nummuliticus, *Duncan & Sladen*: p. 132.
—— ——, var. obesus: p. 134.
—— ——, var. oviformis: p. 135.
—— ——, var. planus: p. 135.
—— rotundus, *Duncan & Sladen*: p. 135.

Genus SISMONDIA, *Desor*, 1857.

Sismondia polymorpha, *Duncan & Sladen*: p. 137.

Suborder ATELOSTOMATA.

Family CASSIDULIDÆ.

Subfamily ECHINONEINÆ.

Genus AMBLYPYGUS, *Agassiz*, 1840.

Amblypygus subrotundus, *Duncan & Sladen*: p. 140.
—— ——, var. conicus: p. 142.
—— patellæformis, *Duncan & Sladen*: p. 144.
—— tumidus, *Duncan & Sladen*: p. 146.
—— latus, *Duncan & Sladen*: p. 148.

Subfamily ECHINOLAMPINÆ.

Genus EOLAMPAS, *Duncan & Sladen*, 1882.

Eolampas excentricus, *Duncan & Sladen*: p. 150.

Genus ECHINOLAMPAS, *Gray*, 1825.

Echinolampas rotunda, *Duncan & Sladen*: p. 152.
—— subconica, *Duncan & Sladen*: p. 155.
—— obesa, *Duncan & Sladen*: p. 157.
—— Sindensis, *d'Archiac*: p. 159.
—— ——, var. hemisphærica, *Duncan & Sladen*: p. 163.
—— angustifolia, *Duncan & Sladen*: p. 164.
—— nummulitica, *Duncan & Sladen*: p. 167.

Echinolampas juvenilis, *Duncan & Sladen*: p. 170.
—— lopadiformis, *Duncan & Sladen*: p. 172.
—— æquivoca, *Duncan & Sladen*: p. 173.
—— sp. (junior): p. 174.
—— sp.: p. 176.

Subfamily ECHINANTHINÆ.

Genus ECHINANTHUS, *Breynius*, 1732.

Echinanthus intermedius, *Duncan & Sladen*: p. 177.

Genus ILARIONIA, *Dames*, 1877.

Ilarionia Sindensis, *Duncan & Sladen*: p. 179.

Genus CASSIDULUS, *Lamarck*, 1801.

Cassidulus subinvaginatus, *Duncan & Sladen*: p. 182.

Genus RHYNCHOPYGUS, *D'Orbigny*, 1855.

Rhynchopygus Calderi, *d'Archiac & Haime*, sp.: p. 184.
—— pygmæus, *Duncan & Sladen*: p. 187.

Family SPATANGIDÆ.

Subfamily SPATANGINÆ.

Genus MICRASTER, *Agassiz*, 1836.

Micraster tumidus, *Duncan & Sladen*: p. 189.

Genus HEMIASTER, *Desor*, 1847.

Hemiaster apicalis, *Duncan & Sladen*: p. 193.
—— nobilis, *Duncan & Sladen*: p. 196.
—— carinatus, *Duncan & Sladen*: p. 198.
—— digonus, *d'Archiac*: p. 200.
—— sp.: p. 201.
—— sp.: p. 201.
—— sp.: p. 202.

Genus BRISSOPSIS, *Agassiz*, 1840.

Brissopsis sufflatus, *Duncan & Sladen*: p. 203.

Genus METALIA, *Gray*, 1855.

Metalia Sowerbyi, *d'Archiac*, sp: p. 206.
—— scutiformis, *d'Archiac*, sp.: p. 209.
—— ——, var. rotunda, *Duncan & Sladen*: p. 211.
—— depressa, *Duncan & Sladen*: p. 211.
—— agariciformis, *Duncan & Sladen*: p. 213.
—— sp.: p. 215.
—— sp.: p. 216.

Genus LINTHIA, *Merian*, 1853.

Linthia orientalis, *Duncan & Sladen*: p. 217.

Genus SCHIZASTER, *Agassiz*, 1836.

Schizaster symmetricus, *Duncan & Sladen*: p. 220.
—— simulans, *Duncan & Sladen*: p. 223.
—— Baluchistanensis, *d'Archiac & Haime*: p. 224.
—— sp.: p. 224.

Genus MOIRA, *A. Agassiz*, 1872.

[*] Moira primæva, *Duncan & Sladen*: p. 225.

Genus BRISSOPATAGUS, *Cotteau*, 1863.

Brissopatagus Sindensis, *Duncan & Sladen*: p. 226.

Genus BREYNIA, *Desor*, 1847.

[*] Breynia carinata, *d'Archiac & Haime*: p. 229.

Genus MACROPNEUSTES, *Agassiz*, 1847.

Macropneustes speciosus, *Duncan & Sladen*: p. 229.
—— rotundus, *Duncan & Sladen*: p. 232.

Genus PERIPNEUSTES, *Cotteau*, 1875.

Peripneustes sp.: p. 234.

Genus EUSPATANGUS, *Agassiz*, 1847.

Euspatangus avellana, *d'Archiac & Haime*: p. 235.
—— cordiformis, *Duncan & Sladen*: p. 238.
—— rostratus, *d'Archiac*: p. 240.

Genus indet. (probably new; and to be classed with the Brissinæ).

? . . . . ? . . . . : p. 241.

Summary of Species of Fossil Echinoidea from the Khirthar Series in Sind.

1. Leiocidaris canaliculata, *Duncan & Sladen*: p. 109.
2. Porocidaris anomala, *Duncan & Sladen*: p. 113.
3. Cyphosoma macrostoma, *Duncan & Sladen*: p. 116.
4. —— undatum, *Duncan & Sladen*: p. 117.
5. Micropsis venustula, *Duncan & Sladen*: p. 119.
6. Temnechinus Rousseaui, *d'Archiac*, sp.: p. 122.
7. Conoclypeus alveolatus, *Duncan & Sladen*: p. 124.
8. —— pinguis, *Duncan & Sladen*: p. 126.
9. —— rostratus, *Duncan & Sladen*: p. 128.
10. —— galerus, *Duncan & Sladen*: p. 129.
11. Echinocyamus nummuliticus, *Duncan & Sladen*: p. 132.
12. —— ——, var. obesus, *Duncan & Sladen*: p. 134.
13. —— ——, var. oviformis, *Duncan & Sladen*: p. 135.
14. —— ——, var. planus, *Duncan & Sladen*: p. 135.
15. —— rotundus, *Duncan & Sladen*: p. 135.
16. Sismondia polymorpha, *Duncan & Sladen*: p. 137.
17. Amblypygus subrotundus, *Duncan & Sladen*: p. 140.
18. —— ——, var. conicus, *Duncan & Sladen*: p. 142.
19. —— patellæformis, *Duncan & Sladen*: p. 144.

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[*] A single example, evidently included accidentally in the Khirthar Collection.

20. Amblypygus tumidus, *Duncan & Sladen*: p. 146.
21. —— latus, *Duncan & Sladen*: p. 148.
22. Eolampas excentricus, *Duncan & Sladen*: p. 150.
23. Echinolampas rotunda, *Duncan & Sladen*: p. 152.
24. —— subconica, *Duncan & Sladen*: p. 155.
25. —— obesa, *Duncan & Sladen*: p. 157.
26. —— Sindensis, *d'Archiac*: p. 159.
27. —— ——, var. hemisphærica, *Duncan & Sladen*: p. 163.
28. —— angustifolia, *Duncan & Sladen*: p. 164.
29. —— nummulitica, *Duncan & Sladen*: p. 167.
30. —— juvenilis, *Duncan & Sladen*: p. 170.
31. —— lepadiformis, *Duncan & Sladen*: p. 172.
32. —— æquivoca, *Duncan & Sladen*: p. 173.
33. —— sp. (junior): p. 174.
34. —— sp.: p. 176.
35. Echinanthus intermedius, *Duncan & Sladen*: p. 177.
36. Ilarionia Sindensis, *Duncan & Sladen*: p. 179.
37. Cassidulus subinvaginatus, *Duncan & Sladen*: p. 182.
38. Rhynchopygus Calderi, *d'Archiac & Haime*, sp.: p. 184.
39. —— pygmæus, *Duncan & Sladen*: p. 187.
40. Micraster tumidus, *Duncan & Sladen*: p. 189.
41. Hemiaster apicalis, *Duncan & Sladen*: p. 193.
42. —— nobilis, *Duncan & Sladen*: p. 196.
43. —— carinatus, *Duncan & Sladen*: p. 198.
44. —— digonus, *d'Archiac*: p. 200.
45. —— sp.: p. 201.
46. —— sp.: p. 201.
47. —— sp.: p. 202.
48. Brissopsis sufflatus, *Duncan & Sladen*: p. 203.
49. Metalia Sowerbyi, *d'Archiac*, sp.: p. 206.
50. —— scutiformis, *d'Archiac*, sp.: p. 209.
51. —— ——, var. rotunda, *Duncan & Sladen*: p. 211.
52. —— depressa, *Duncan & Sladen*: p. 211.
53. —— agariciformis, *Duncan & Sladen*: p. 213.
54. —— sp.: p. 215.
55. —— sp.: p. 216.
56. Linthia orientalis, *Duncan & Sladen*: p. 217.
57. Schizaster symmetricus, *Duncan & Sladen*: p. 220.
58. —— simulans, *Duncan & Sladen*: p. 223.
59. —— Baluchistanensis, *d'Archiac & Haime*: p. 224.
60. —— sp.: p. 224.
61. Moira primæva, *Duncan & Sladen*: p. 225.
62. Brissopatagus Sindensis, *Duncan & Sladen*: p. 226.
63. Breynia carinata, *d'Archiac & Haime*: p. 229.
64. Macropneustes speciosus, *Duncan & Sladen*: p. 229.
65. —— rotundus, *Duncan & Sladen*: p. 232.
66. Peripneustes sp.: p. 234.
67. Euspatangus avellana, *d'Archiac & Haime*: p. 235.
68. —— cordiformis, *Duncan & Sladen*: p. 238.
69. —— rostratus, *d'Archiac*: p. 240.
70. ? ? (? new genus, allied to Brissinæ): p. 241.

III. *Description of the Fossil Echinoidea from the Khirthar Series of Strata in Western Sind.*

Order **ECHINOIDEA ENDOCYCLICA.**

Family CIDARIDÆ.

Genus CIDARIS, *Klein*, 1734.

(See *antea*, p. 7, Part i.)

Subgenus LEIOCIDARIS, *Desor*, 1854.

The subgenus *Leiocidaris* is characterized from the true *Cidaris* by the conjugate pores, and distinguished from *Phyllacanthus*, Brandt (=*Rhabdocidaris*, Desor) by the smooth and non-crenulate tubercles. The form of the spines is also very different in the last-named group of species. The character of the ambulacral area is evidently one of morphological importance, whilst the distinction based on the tubercles and the spines would seem, from the known variability of these parts in *Cidaridæ*, to be more doubtful. In his recent work on the Eocene Echinoidea from Egypt and the Libyan Desert*, P. de Loriol maintains the genus *Rhabdocidaris* of Desor, and includes therein (1) the species of *Rhabdocidaris sensu stricto*, (2) the species of *Rhabdocidaris* with non-crenulated tubercles, (3) the species of *Leiocidaris* of Desor and Dames amended, (4) the recent species of *Phyllacanthus* of A. Agassiz, and (5) the genus *Stephanocidaris* of A. Agassiz. Although we place the greatest importance upon every opinion expressed by our learned contemporary, we still consider that Brandt's genus merits recognition; and although we are far from insisting that the characters upon which *Leiocidaris* is separated from *Phyllacanthus* (=*Rhabdocidaris*) are of any great value, we regard the grouping above proposed as somewhat too sweeping in the present state of our knowledge; we therefore retain provisionally the subgenus *Leiocidaris* rather as a useful centre around which a number of species may be grouped, than as an expression of our opinion upon the morphological importance of the test-characters upon which the division is based.

1. Leiocidaris canaliculata, *Duncan & Sladen*. Plate XXI, Figs. 1–9.

Form circular, subglobular, rather high, the height being nearly three fourths of the breadth (or, taking the mean of three specimens, is as 0·7 : 1 approximately). Test very slightly depressed on the abactinal surface, moderately inflated at the ambitus, the contraction of the test being greater below that line than above.

Ambulacra very slightly flexuous, rather broad, contracting towards the apex, and also, but in a less degree, towards the peristome. Poriferous zones deeply sunken, as broad as the whole interporiferous area. Pores transversely elliptical, wide apart, the pores of a pair united by a faint but distinct groove, which is further emphasized by the presence of a thin elevated ridge separating the neighbouring pairs. The outer pores are more elongate or pyriform than the inner ones; and there are 14 or 15 pairs of pores opposite to one of the largest interambulacral plates at the ambitus. The interporiferous areas are narrow, and are furnished with two rows of minute mammillated miliary tubercles, placed at the extreme margins of the area, the space between being occupied by very minute miliary granules, regularly arranged, there being at the ambitus, in full-sized specimens, six granules on each plate, placed in two horizontal rows of three accompanying and on the inner side of each of the mammillated granules above mentioned. Towards the extremities of the area the interior series of granules diminish in number, until at the very apex not more than one or two stand between the outer marginal series, which latter are continuous from apex to peristome. Similarly in small-sized specimens there may not be more than four of the interior granules on each plate even at the ambitus, and midway between that and the extremities not more than two; the idea of two horizontal lines accompanying each mammillated ambulacral granule being maintained all through, even towards the apex, by the elongation of the granules transversely.

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* Palæontographica, N. F. x. 1 (xxx.).

The interambulacral areas are rather more than four times the width of the ambulacra at their widest part, and there are two rows of seven or eight primary tubercles in each interambulacrum. The primary tubercles are of small elevation, perforate, and not crenulate; and their mamelons are comparatively large, having the edge bevelled rather than rounded. The scrobicules are wide, circular, and extend close up to the edge of the plate bordering on the poriferous zone. The scrobicular ring is complete, composed of 16 or 17 moderately developed, mammillated granules, and touches the edge of the plate which borders on the poriferous zone, as well as the actinal and abactinal margins of the plate. There are in consequence on the poriferous side of the plate only a few small miliary granules occupying the upper and the lower corners of the plates. The miliary zone, on the other hand, is remarkably wide, and is slightly impressed along the zigzag median suture; it is occupied by a fine, uniform, miliary granulation, regularly arranged in transverse parallel lines, which extend in gentle curves across the plate, and are continued in uninterrupted series from one plate on to the adjacent plate of the neighbouring column. Slight superficial furrows run between every two or three lines of granules, thus marking off the miliary zone into gently curved bands of granules, which extend from the scrobicular ring of one tubercle to that of the two neighbouring scrobicules in the companion column, the extremities of each band being closed by one of the mammillated granules of the scrobicular ring.

Peristome subcircular, small, 13 millim. in diameter in a specimen 35 millim. in diameter at the ambitus, and 13·5 millim. in another of 37 millim. at the ambitus. Apical disk subpentagonal and rather larger than the peristome. Details of the apical system unknown. On one of the fragments of this Cidarid a portion of a spine is attached, of which a drawing is given in fig. 7; it is altogether unlike any of the spines we have received from the Ranikot series.

Remarks. At first sight this species might be regarded as nearly related to the *Cid. Verneuili* of d'Archiac & Haime, as figured in the An. foss. de l'Inde. A careful study of the description of that form and of the type preserved in the Museum of the Geological Society at once dispels such an opinion; indeed they appear to resemble one another in little else than the great breadth of the miliary zone, the lineal arrangement of the granulation borne upon it, and the absence of granulation between the scrobicular ring and the poriferous zone. *L.* (*C.*) *canaliculata* differs from *C. Verneuili* in the greater height of the test, the total difference of the contour of the profile, the character and ornamentation of the ambulacra, the relative size of the peristome, and the character of the ornamentation of the miliary zone. Furthermore it is especially mentioned in the description of *C. Verneuili*, that the pairs of the ambulacral pores are separated by a granule, whilst in the form under notice they are widely spaced and united by a furrow. The ornamentation of the miliary zone of *C. Verneuili* has simply a single row of granules in each band, whilst two, three, or even more are the normal number in our present form.

Although the condition of preservation of the type in London leads to the inference that the diagnosis must probably have been written from a more perfectly preserved specimen, the conclusions as to the distinctness of *L.* (*C.*) *canaliculata* are in no way invalidated.

The above considerations were carefully balanced when describing the fossils of the Ranikot series, and our retention of d'Archiac and Haime's name of *Verneuili* for the Cidarid plates there found was dictated more by a wish to preserve the nomenclature of our learned predecessors and by a repugnance to add one single unnecessary name to an already overburdened synonymy, than from any positive conviction that the fragments in question were really identical with the badly preserved type at the Geological Society. The condition of that specimen is so unsatisfactory that a definite conclusion is impossible.

Young Form. A small specimen, 10 millim. in diameter and 6 millim. in height, obtained from the same beds as some of the typical examples of *Leiocidaris canaliculata*, we refer provisionally to the same species. The test is undoubtedly that of an immature Cidarid, and does not present any characteristic specific features; under such circumstances it seems preferable to regard it as the young of the associated form rather than that of an unknown species, which would require to be named from this insufficient material. The interambulacral areas have only 4 or 5 plates in each column, the primary tubercles are comparatively large and prominent, and the relative breadth of the ambulacra is rather greater than in the fully grown form. The scrobicule occupies nearly the whole of the plate, and the miliaries of the scrobicular ring are the only regularly defined granules present, excepting a few irregular and often elongate granules standing external to them in the miliary zone at the ambitus. In the ambulacra the pairs of pores are slightly oblique, being directed downwards and inwards towards the median suture of the area; the adoral margin of the plate is also directed slightly inwards, and is thus at a little lower level than the next succeeding plate—a feature giving the appearance of imbrication. In the interporiferous areas only the two outer rows of large granules are present throughout, with occasionally a trace (quite microscopic) of the inner small series, the large granule occupying, however, nearly the whole of the space between the pore and the median suture of the area.

Dimensions. The following are the measurements of three specimens:—

	a. millim.	b. millim.	c. millim.
Height	28	25	25
Breadth	40	34	37

Localities. In the Khirthar series of strata:—i. Twenty-four miles west of Kotri (entering the hills on the road to Búla Khán's Thána). Survey-number $\frac{G\,290}{72}$.

ii. Dháran Pass, near Laki. Survey-number $\frac{G\,300}{2}$.

iii. Gágar hill, east side of the Súrjána range. Survey-number $\frac{G\,302}{114}$.

Illustrations of the Species in Plate XXI.

Fig. 1. The test seen in profile: natural size.
2. Actinal view of a part of the test: natural size.
3. Plates of the interambulacral area: magnified.
4. Ambulacral plates a little above the ambitus: magnified.
5. Ambulacral plates from a larger specimen at the ambitus: magnified.
6. Ideal section of an ambulacral area.
7. A portion of a spine: magnified.
8. A young specimen seen in profile: magnified.
9. Ambulacral plates from the same: magnified.

Genus POROCIDARIS, *Desor*, 1854.

Test circular, depressed above and below, inflated at the ambitus.

Ambulacral areas broad and straight. Poriferous zones broad, scarcely sunken, with simple pairs of pores directly superposed. Pores wide apart, united by a conjugating furrow. Interporiferous areas broad, with horizontal series of miliary granules.

Interambulacral areas wide, with two vertical rows of primary tubercles. Primary tubercles with small mamelons, perforate, deeply crenulate. Scrobicules more or less transversely oval, with shallow grooves more or less defined radiating from the periphery towards the centre along the flank of the tubercles, with or without pores or depressions at the outer extremity of the grooves. Scrobicular ring with a tendency to become confluent.

Peristome small, decagonal.

Spines flattened, with strongly serrated edges.

This genus was established by Desor* for the reception of some isolated plates with scrobicules of the form and dimensions of large Cidarids, but characterized by having the periphery perforated by a circle of pores, lodged in small furrows, radiating round the scrobicule. Tubercles crenulated and perforated. Spines compressed, lamelliform, and strongly denticulated. Subsequently a recent Cidarid from the North Atlantic was referred to this genus by Sir Wyville Thomson, notwithstanding that the form appeared anomalous in being deficient in the very character upon which the genus was originally founded, viz. the presence of pores in the scrobicule. The radiating impressions, however, were present; and Sir Wyville Thomson remarked, "It is perfectly conceivable that these depressions may sometimes actually go through the test, or at all events leave it so thin that the action of water and attrition during the process of fossilization may be well supposed to have completed the perforation"*. This latter remark appears to us highly sagacious and important.

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* Synop. Échin. foss. pp. 46, 47.

The first complete fossil test of *Porocidaris* known was that described by de Loriol from the Nummulitic strata of Egypt†. He agrees with Thomson in the reference of the recent form to the genus, and points out the interesting fact that both the pores and the pits or grooves may be wanting on the same test—a circumstance probably dependant upon their position thereon. It would hence appear that the scrobicular pores and radiating grooves are of comparatively secondary importance.

1. POROCIDARIS ANOMALA, *Duncan & Sladen*. Plate XXI, Figs. 10–14.

Form subcircular, turban-shaped, depressed, the height being about one half of the diameter, moderately inflated at the ambitus, the contraction of the test more rapid actinally than abactinally. The test surrounding the actinostome is somewhat depressed.

Ambulacra straight, very broad, measuring two fifths of the interambulacral area at the widest part, and contracting gradually towards the peristome, where it is half its greatest breadth. The contraction towards the apical disk is not so great. Poriferous zones very broad, scarcely sunken, half as wide as the interporiferous area. Pores wide apart, the inner one slightly elliptical transversely, the outer one very decidedly so and often contracting somewhat inwardly. The space between the pair of pores is channelled by a slight groove, and a faint ridge may be traced in well-preserved plates passing from the upper margin of the one pore to the lower margin of the companion. A delicate ridge or keel running along the upper aboral margin of each plate separates the neighbouring pairs of pores. There are eight pairs of pores opposite one of the largest interambulacral plates at the ambitus.

The interporiferous areas are broad, twice the width of the poriferous zone, measuring 4 millim. in the largest specimen, and are furnished with six vertical rows of minute mammillated miliary tubercles. There are consequently three tubercles upon each plate; the outermost is largest, and stands close to the inner pore and rather nearer the aboral than the adoral margin of the plate; the second is rather smaller, and stands in the middle of the plate; the innermost tubercle is much smaller, and is situated nearer the adoral margin of the plate; the arrangement of the tubercles is consequently slightly oblique upon the plate.

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* Phil. Trans. vol. clxiv. p. 727.

† 'Monogr. des Échinides contenus dans les couches Nummulitiques de l'Égypte,' 1881, p. 5.

The interambulacral areas are twice and a half the breadth of the ambulacra at their widest part—the ambulacra being 8 millim., the interambulacra 20 millim. There are two rows of about 12 primary tubercles in each interambulacrum (possibly 13, but the number cannot be stated definitely on account of the concealment of the abactinal area by matrix). The primary tubercles are of moderate height, the neck broad and deeply crenulated (about a dozen being present), and the mamelon very small, subangular at the margins, and perforate. The scrobicules are wide and transversely oval*. The scrobicular circle is subcomplete, and more or less confluent adorally and aborally, composed of 19 or 20 small, mammillated, miliary granules, scarcely larger than the rest of the granulation of the plate. The miliaries are uniformly and rather widely spaced and all are mammillated. The space between the scrobicular ring and the poriferous zone has about two alternating series of miliaries external to those of the ring; the space between the median suture of the area and the scrobicular ring is more than twice as broad, and contains, in addition to three or four alternating series of miliaries external to the scrobicule, a number of granules which gradually diminish in size as they recede from the scrobicular ring. This gives the miliary zone a somewhat naked appearance. In some plates a faint indication of delicate furrows running from the miliary zone outwards towards the scrobicule may be made out, inclosing single series of granules; but this is by no means persistent, and the furrows seldom extend the whole way.

In primary tubercles where the preservation is perfect, shallow radiating grooves or flutings may be traced at the base of the boss, deepest at the very margin of the scrobicule, about 16 to 20 in number all round, although their presence is very indistinct adorally and aborally. The character is very feebly marked throughout, and where weathering influences have taken place is altogether undiscernible.

Peristome decagonal or subpentagonal, small, 15 millim. in diameter in a test 49 millim. in diameter at the ambitus. Interambulacral plates prominent, with margin incurved at the median suture and rounded towards the poriferous zones, simulating an actinostomial indentation. Apical disk unknown.

Radioles. The weathered longitudinal section of a primary radiole is present amongst the matrix on the abactinal area, and also several fragments. This spine is of moderate breadth and very slightly expanded as it increases in length. At each side occur uniform, widely and equidistantly placed serrations, and the shaft is probably compressed. The articulating facet is small in correspondence with the small mamelon. The head is short and expands very rapidly, the ring prominent. The shaft contracts gradually a short way outward from the ring, and again expands up to about the second serration; outward beyond this the expansion is very slightly, if at all, continued.

Numerous miliary spinelets are preserved upon the test; they are elongate, delicate, compressed, slightly tapering and rounded at the extremity, all uniformly marked with a very fine longitudinal striation. A few other spinelets, more delicate, elongate, and subcylindrical, are also present; these do not appear to be the shafts of pedicellariæ.

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* This character has unfortunately not been sufficiently shown by our artist in his drawings of this species.

Young Form. A smaller specimen than the type, from another locality, measuring 33 millim. in diameter, which we regard as belonging to the same species, presents several interesting features worthy of note. The scrobicules are perfectly circular, excepting the faintest trace of flattening in one or two instances at the ambitus; and the scrobicular ring is more nearly complete, being imperfect on the aboral margin of the plate only. The miliaries that form the ring are distinctly larger than any of the rest, and those in the miliary zone are quite microscopic and represented only by most feebly developed and widely spaced granules. In the interporiferous (ambulacral) area the granulation is also very minute. The outermost granule, although almost microscopic, is the only one present throughout; the second is only sometimes represented; and the occurrence of any trace whatever of the innermost miliary is most uncertain, the space for its presence alone being always maintained.

Remarks. It is not without considerable hesitation that we have placed this magnificent form in the genus *Porocidaris*, presenting as it does in such a very feeble manner the primary character which would at first sight be regarded as the most conspicuous feature of Desor's genus. The presence of the pits is not of such great importance, however, after all, it being a character subject to extreme variation, and often absent altogether in the existing species of *Porocidaris*[*]. After careful study of the fossils under notice, we feel justified in adhering to the present determination.

Dimensions. The largest specimen (which is rather distorted) measures about 48 millim. in breadth, and about 25 millim. in height. The smaller specimen is 33 millim. in breadth, and 17 millim. in height.

Localities. In the Khirthar series of strata:—i. Twenty-four miles west of Kotri (entering the hills on the road to Búla Khán's Thána). Survey-number $\frac{G\,280}{72}$.

ii. Uncertain, said to be from near Jakhmari, Laki range. Survey-number $\frac{G\,304}{21}$.

Illustrations of the Species in Plate XXI.

Fig. 10. The test seen in profile: natural size.
11. Actinal view of a part of the test: natural size.
12. An interambulacral plate, with the adjacent portion of the ambulacral area: magnified.
13. Ambulacral plates: magnified.
14. Outline of fragment of a spine: slightly magnified.

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[*] Wyville Thomson, "On the Echinoidea of the 'Porcupine' Deep-sea Dredging-Expedition," Phil. Trans. vol. clxiv. (1874), p. 727.

Family GLYPHOSTOMATA.

Subfamily DIADEMATIDÆ.

Genus CYPHOSOMA, *Agassiz*, 1840.

(See *antea*, p. 31, Part ii.)

1. Cyphosoma macrostoma, *Duncan & Sladen*. Plate XXII, Figs. 8–10.

Test of moderate size, circular in marginal contour, much depressed, the diameter being more than twice and a half the height, flatly convex above, slightly concave beneath, not greatly impressed around the peristome, which is large; margin rounded and tumid.

Ambulacral areas comparatively wide, more than half the breadth of the interambulacral area. Poriferous zones straight, or with a slight tendency to flexure; pores arranged in simple pairs, excepting at the peristome, where there is a little crowding, and a few biserial pores or even arcs of three are produced. The pores of a pair are separated by a slight eminence, and a costal ridge is produced from this along the upper margin of the inner pore, by which this is separated from the neighbouring pore of the succeeding pair. The ridge is not prolonged between the outer series of pores, and at its inner extremity usually terminates in a granule on the ambulacral plate. The inner pore is transversely elongate, larger than the circular outer pore, and is excavated out of the adoral margin of the plate. There are four, or occasionally five, poriferous plates to each whole ambulacral plate. The interporiferous areas have two rows of large primary tubercles, 14 or 15 in each series; these tubercles are crenulate and imperforate and occupy most of the plate, and are accompanied by a few unequal-sized and irregularly-placed granules, a more or less definite row often occurring on the aboral margin of the plate. None of the granules can be said to rank as secondary tubercles.

Interambulacral areas with two rows of large primary tubercles, 12 or 13 in each, very slightly larger than those of the ambulacral areas, which they resemble in every respect, and diminish slightly in size towards the apical extremity of the series. The primary tubercles are placed rather nearer to the median interambulacral line than the middle of the plate. Between the primary tubercle and the poriferous zone are two rather large secondary tubercles, one above the other and slightly oblique, the uppermost being rather nearer to the primary tubercle. This double series does not extend very far beyond the ambitus on the abactinal surface, but is continuous up to the peristome, the tubercles being considerably diminished in size. Several small and irregularly-placed granules are present on either side of the secondary tubercles, and a few similar and unequal-sized granules occupy the inner portion of the plate between the primary tubercle and the median suture, one standing near the inner extremity of the aboral margin being usually the largest in the neighbourhood of the ambitus, but much too insignificant to be ranked as a secondary tubercle. The miliary zone along the median line of the interambulacral area is not naked. Eight to ten pairs of pores stand opposite two of the interambulacral plates.

Peristome very wide, equal in diameter to one half of the diameter of the test, circular or subdecagonal in outline, rather deeply indented by wide, well-developed mouth-slits. The peristomial margin of the ambulacral area is very broad and convex towards the mouth, with a graceful incurving at the median line. The margin of the interambulacral areas is comparatively straight between the limits of the slits, slightly convex in the median portion, and faintly incurved on either side adjacent to the sharp angular prominence formed by the slit. The margins of the slit are thickened and turned backward.

Apical disk wanting. The vacant space is of moderate size, nearly equal to one third of the diameter of the test.

Remarks. Although this form is very depressed, and scarcely so turban-shaped as a typical *Cyphosoma*, the slightly sinuous poriferous zones, the large primary tubercles, and the wide peristome all warrant its inclusion in that genus. The species is distinguished from any with which we are acquainted by the position of the primary tubercles on the interambulacral plates, and by the accompanying pair of obliquely-placed secondaries, together with the large and well-characterized peristome.

Dimensions.

	millim.
Diameter of the test	26·5
Height of the test	10
Diameter of peristome	13·2
Diameter of apical disk	9

Locality. Khirthar series of strata. Probably from the Lower Nummulitic Limestone: picked up in the infra-Nummulitic area. Hills under Jakhmari Peak, Laki range, west of Amri. Survey-number $\frac{G\,280}{69}$.

Illustrations of the Species in Plate XXII.

Fig. 8. Profile view of the test: natural size.
9. Actinal view of the test, showing peristome: natural size.
10. Ambulacral and interambulacral plates: magnified.

2. CYPHOSOMA UNDATUM, *Duncan & Sladen.* Plate XXII, Figs. 11 & 12.

There is a test in the Khirthar series of a rather large species of Echinoid which we refer to this genus; but unfortunately the specimen is so badly preserved, and the greater portion of the detail so obscurely masked by a thin layer of matrix, that a complete description is impossible. The following particulars are all that can be furnished:—

Test circular in marginal contour, considerably depressed, the diameter being about twice and a half the height, regularly convex above, sloping down to a rather thin margin or side, which is rounded and only slightly tumid.

Ambulacral areas less than one half the breadth of the interambulacral areas. Poriferous zones very flexuous at the ambitus, where there are six or seven poriferous plates to each whole or compound ambulacral plate, and the pairs of pores are arranged in a vertical semicircular arc. Towards the apical portion of the area the poriferous zones become straighter, and the pairs of pores stand in almost simple rectilineal series. The ambulacral plates bear one large primary tubercle and a few widely spaced, uniform, but irregularly disposed granules on the inner portion of the plate, and also a few on the aboral margin of the plate.

The interambulacral plates are wide, with one large primary tubercle, equal in size to those of the ambulacra, placed exactly in their midst, and surrounded, except on the adoral side, by a more or less indistinct circlet of granules. There is one small secondary tubercle midway between the primary and the poriferous zone, and two or three small, scattered miliaries. The inner portion of the plate is occupied only by a few uniform and very widely spaced granules, which are quite irregular in their arrangement, the general paucity of granules giving a very naked appearance to the plate. The primary tubercles are crenulate and imperforate, the ambulacral series being equal in size to the interambulacral.

Remarks. In profile view and in many of the points of detail this form would seem to present some superficial affinities to the Echinoid named *Echinometra Thomsoni* by d'Archiac and Haime*. It differs, however, in several of the most essential particulars recited by those authors in their description; and it would obviously be impossible to draw a just comparison between the fragmentary material at our disposal and the species in question, without a direct comparison with the type; respecting the generic association of which we may here remark that we feel much hesitation in accepting the determination of our learned predecessors. The type of *Echinometra Thomsoni*, d'A. & H., is not to be found in the collection at the Geological Society in London. There is, however, a specimen which corresponds with the fig. 13*a* (*loc. cit.*) and which bears a ticket in the handwriting of M. J. Haime inscribed "*Echinometra Forbesi*, J. Haime." This specimen is in a much better state of preservation than the Sindian fossil under notice, and we consider it to be a different species. The arcs of pores are more curved, and the curvature is maintained up to the apex, whereas in our form the poriferous zones become straight. The secondary tuberculation is much more developed, and there is much difference in the contour and general facies. Furthermore, M. Haime's type is in a red matrix, resembling that of the Ranikot series, whilst the present fossil is from the true Nummulitic Limestone. Carefully weighing the foregoing considerations, we feel justified in regarding the Khirthar specimen as an independent species. It is much to be desired that more perfect material will be forthcoming, in order that the description may be completed.

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* An. foss. de l'Inde, p. 207, pl. xiii, figs. 13*a*, 13*b*.

Dimensions.

	millim.
Diameter of the test	42
Height of the test	17

Relative proportion of the ambulacral to the interambulacral area, at their greatest breadth, 42·4 per cent.

Locality. Khirthar series of strata. Dháran Pass (east side), near Laki. From the white limestones above the shales. Survey-number $\frac{G\ 280}{63}$.

Illustrations of the Species in Plate XXII.

Fig. 11. Outline of the profile contour of the test: natural size.
12. Ambulacral and interambulacral plates: magnified.

Genus MICROPSIS, *Cotteau*, 1856.

Test of moderate size, circular, subhemispherical or often more or less inflated, concave beneath.

Poriferous zones straight. Pores arranged in simple pairs in uniserial series.

Primary tubercles in both series relatively small, delicate, and numerous, finely crenulate, imperforate, and forming more or less regular vertical series.

Peristome small and slightly indented.

From the above diagnosis it will be seen that the differences which separate this genus from *Cyphosoma* are individually those of degree only—the uniserial poriferous zones, the small, delicate, and comparatively more numerous primary tubercles, and the small and slightly indented peristome being the characters upon which the division is based. Although the value of these characters *per se* would appear small, their combination produces a facies very different from that of an ordinary *Cyphosoma*. On this account it seems convenient to retain the section, although its zoological validity might well be contested, as P. de Loriol has already pointed out*.

1. MICROPSIS VENUSTULA, *Duncan & Sladen*. Plate XXII, Figs. 1–7.

The test is of moderate size, circular or subpentagonal in marginal contour, depressed, height less than one half the diameter, regularly convex above, concave beneath, and rather deeply impressed around the peristome, which is small; margin well rounded and tumid.

Ambulacral areas narrow, less than one half the breadth of the interambulacral area at the widest part, slightly prominent, the interporiferous area being somewhat raised. Poriferous zones straight, pores arranged in simple series throughout, no doubling present either at the apical or peristomial extremity. The pores of a pair are separated by a slight granuliform eminence, and a faint costal ridge, appearing as lateral prolongations of the granule, occurs on the aboral margin of the ambulacral plate, and thus separates the adjoining pairs of pores. The inner pore of each pair is close to the adoral margin of the plate, often excavating it; the outer pore is midway between the margins. There are three poriferous plates to each whole ambulacral plate. The interporiferous areas have two rows of primary tubercles, about 18 to 20 in each, one standing close to each poriferous zone. The tubercles are crenulate, have a moderately large imperforate mamelon, and are little, if at all, less than the primary interambulacral tubercles. A few irregularly-disposed and widely-spaced granules occupy the plate on the inner side of each primary tubercle. Near the ambitus, and extending up to the peristome, one of the granules in each plate is much larger than the rest and is mammillated; and these form two alternating series of small secondary tubercles. Each of the marginal primary tubercles is separated from its neighbour by a regular transverse line of three small granules, which stands on the aboral margin of the plate.

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* Descrip. Échin. tert. de la Suisse, p. 26 (Mém. Soc. Paléont. Suisse, vol. ii.).

Interambulacral areas wide, twice and a half the breadth of the ambulacral areas, and are furnished with two rows of primary tubercles, 15 to 17 in each; these are placed rather nearer to the poriferous zone than midway on their respective plates. At the ambitus there is a moderate-sized secondary tubercle at either side of the primary. The inner series does not extend very far abactinally above the ambitus, and becomes insignificant towards the peristome. The outer series extends rather further on the abactinal surface, but disappears entirely about midway between the ambitus and apex. The primary tubercle is surrounded by a more or less distinct circle of small miliary granules, which is confluent with the neighbouring circle on the lower margin. The plate is further ornamented with a small number of widely-spaced, irregularly-disposed, unequal granules, and a well-defined, naked, miliary zone is preserved from the ambitus up to the apical disk. The primary tubercles maintain their size very uniformly throughout the series, the diminution towards the extremities being very slight. There are eight or nine pairs of pores opposite two of the interambulacral plates of the ambitus.

Peristome decagonal, small, impressed; diameter rather more than one third the diameter of the test. Mouth-slits rather deep, wide, and well rounded, margined with a slight rim.

Apical disk well developed, though forming a rather narrow ring; periproctal aperture suboval, with the right posterior ocular plate always included. The other oculars are smaller, regularly pentagonal in outline, and the puncture is minute and situated at the extreme edge of the adoral margin. The genital plates are somewhat broader than long, the adoral prolongation rather acute; the genital pores are large and oval, and placed nearer to this angle than to the periproctal margin. The right anterior genital plate is scarcely larger than the others, and bears a compact prominent subtubercular madreporiform body; the other four genitals have a row of four or five granules along their margin, and there are two or three on the included ocular. The excluded oculars have a single granule on the centre of the plate.

Variations. The form, as a whole, is remarkably constant, the chief variations noticed being those which affect the marginal contour, tending to a more or less pentagonal outline, in consequence of the inflation of the radial areas, and the greater or less development of the secondary series of tubercles on the interambulacral plates, these in some examples being confined to the ambital region, whilst in others they extend further towards the peristome or towards the apex, sometimes the inner and sometimes the outer series being the most extensive.

Remarks. This species cannot be mistaken for any of its Indian congeners; the form of the test, the small and regular tuberculation, and the small peristome readily characterize it. It is distinguished from the Egyptian *M. mokattanensis*, Cotteau, by the form of the test, which is less turban-shaped and more subconically convex abactinally, by the shorter series of secondary tubercles on the interambulacral plates, and by the much more scanty miliary granulation. *Micropsis venustula* has very close resemblance to *Cyphosoma superbum*, Dames, from San Giovanni Ilarione, but differs in the form of the test, and in having the secondary tubercles of the interambulacral plates smaller, less regular, and more confined to the region of the ambitus. The primary tubercles are also smaller. *M. venustula* resembles *C. superbum* in having straight uniserial poriferous zones; and the differences which separate the two forms generically appear to be very slight, and may well in such a case suggest doubts as to the propriety of maintaining both the genera as distinct.

Dimensions.

	a. millim.	*b.* millim.	*c.* millim.	*d.* millim.
Diameter of the test . . .	22	21	20·5	16
Height of the test	10	11	10	8
Diameter of peristome . .	8·25	—	7	6

Localities. In the Khirthar series of strata :—i. Twenty-four miles west of Kotri (entering the hills on the road to Búla Khán's Thána). Survey-number $\frac{G\,280}{72}$. A large series of specimens were obtained from this locality.

Several examples were also found at

ii. Gágar Hill, east side of the Súrjána range. Survey-number $\frac{G\,302}{114}$.

Illustrations of the Species in Plate XXII.

Fig. 1. Profile view of the test: magnified twice.
2. Abactinal view of the test: natural size.
3. Actinal view of the test, showing peristome: natural size.
4. Abactinal view of the test of a pentagonal variety: natural size.
5. Apical disk: magnified 7 times.
6. Ambulacral and interambulacral plates: magnified.
7. Diagram of the poriferous plates of the ambulacral plate.

Subfamily TEMNOPLEURIDÆ.

Genus TEMNECHINUS, *Forbes*, 1852.

Test spherical or tumidly turban-shaped. Poriferous zones almost straight. Plates of the ambulacral and interambulacral areas with fossettes upon their horizontal sutures. Primary tubercles non-crenulate and imperforate. (Occasionally a crenulate tubercle is seen.) Apical system well developed and regular. Peristome small, sunken, and with very small indentations.

In a former page (part ii. p. 36) we have remarked at length on various genera of the subfamily *Temnopleuridæ*. Furthermore, from the study of a large series of specimens in various states of preservation obtained from higher beds than those to which the present fragment is assigned, we have been enabled to discuss critically[*] the group of species referred by d'Archiac and Haime to the genus *Temnopleurus*. We have there shown that none of the forms described in the 'Animaux fossiles de l'Inde' belong to *Temnopleurus*, in that they are deficient in the special sutural pits and the knob-and-socket jointing of the plates, which have been demonstrated by one of us[†] to characterize the *Temnopleuridæ*; in that they possess a peculiar superficial ornamentation on the plates, which does not occur in the true *Temnopleuri*; and in that the tubercles are non-crenulate and imperforate, whilst those of *Temnopleurus* are crenulate and perforate. On the other hand, the Indian species under notice accord in every essential point with the genus *Temnechinus* of Forbes; and it is gratifying that the additional material at our disposal has enabled us to confirm the position taken by him.

1. Temnechinus Rousseaui, *d'Archiac*, sp. Plate XXII, Figs. 13 & 14.

Temnopleurus Rousseaui, *d'Archiac* (1850), *Hist. des progrès de la Géol.* t. iii. p. 257.
—— ——, *d'Archiac & Haime* (1853), *Descrip. An. foss. de l'Inde*, p. 205, pl. xiii, fig. 10.

There is a single fragmentary test of a small Echinoid in the collection from the Khirthar series which we refer, although with much hesitation, to d'Archiac and Haime's species. The fossil, unfortunately, is in such a weathered and unsatisfactory state that an accurate determination is impossible. All the types of MM. d'Archiac and Haime's species of *Temnopleurus* in the collection of the Geological Society are also very badly preserved, and it is often impossible to make out the details delineated in the exquisite drawings in the 'Animaux fossiles de l'Inde.' It appears to us that the imagination of the artist has been guided by ink-spots placed in the cavities and other marks.

The following are the particulars of such detail as can be noted in the fragmentary specimen before us:—

[*] 'The Tertiary Fossil Echinoidea of Kachh and Kattywar' (1883), p. 54 *et seq.*

[†] P. Martin Duncan, Journ. Linn. Soc., Zool. vol. xvi. p. 343.

Test small, circular in marginal contour, moderately high and subconical above, height nearly equal to two thirds of the diameter, gently rounded at the margin and flat beneath. Peristome subcircular or decagonal, equal in diameter to one third of the diameter of the test. Mouth-slits very faintly indented. Ambulacral areas nearly equal in width to two thirds of the breadth of the interambulacral areas (4 mm. to 6·5 mm. accurately). Poriferous zones rather wide, pairs of pores arranged in oblique lines of threes. There are three poriferous plates to each whole ambulacral plate, the middle one being small and wedge-shaped, hardly more than half the breadth of the other two, between which it has the appearance of being intercalated. The pair of pores borne by this small median plate is the last and most outward pair of each of the oblique lines of threes; whilst the first pair of the oblique series, which is also the most inward and aboral, is borne on the lowest or adoral poriferous plate of the next more aboral ambulacral plate. The three pairs of pores which constitute the oblique lines of threes consequently do not correspond with the three pairs of pores comprised in each individual ambulacral plate. The tuberculation of the test is entirely destroyed and the ambulacral plates are weathered down so as to become roof-shaped and bevelled towards the aboral and adoral margins. There appear to be traces of two rows of primary tubercles in the interporiferous area, placed marginally; and there are also traces of vertical prolongations (? costal ridges) uniting the primary tubercle with its succeeding neighbour.

The ornamentation of the interambulacral areas is similarly destroyed, and the plates are roof-shaped and bevelled down to the adoral and aboral sutures, like the plates of the ambulacral area. Traces exist of a central primary tubercle accompanied at the ambitus by two smaller ones on either side, thus forming a horizontal row of five upon the plate. The companion tubercles decrease in number upon the upper portion of the abactinal surface and towards the peristome, the central primary alone being present at the apex, whilst three are continued to the peristome. Vertical prolongations or ridges proceed from each of the tubercles and unite them with the corresponding tubercles of the neighbouring plate in vertical succession, producing, *along with the effects of weathering*, the remarkable horizontal series of round, isolated, pit-like cavities along the suture-lines of the interambulacral plates. If these were filled in with ink, as in d'Archiac and Haime's type specimen, the similarity would be complete.

Remarks. We have little doubt that the fossil under consideration is the same species as that described in the monograph of our French predecessors; but the condition of the specimen is such as to render it perfectly useless for any critical purposes. From the lithological appearance we have very grave doubts about this specimen really belonging to the Khirthar series. It is possible that some mistake may have been made in the locality assigned to the specimen, and we would urge caution in accepting this as a Khirthar form until further verification is forthcoming. These doubts are strengthened by the fact that *T. Rousseaui* (together with the other species of *Temnechini* described by d'Archiac and Haime as *Temnopleuri*) are in reality Miocene species; and to this we have referred at greater length in the 'Description of the Echinoidea of Kachh and Kattywar.'

Dimensions. Diameter of the test 18 millim.; height 11 millim.; peristome 6 millim.

Locality. Gágar Nala, near the Darwat, on the Báran. (Khirthar series of strata.) Survey-number $\frac{G\ 302}{108}$.

Illustrations of the Species in Plate XXII.

Fig. 13. Profile view of the test: magnified twice.
14. Ambulacral and interambulacral plates: magnified.

Order ECHINOIDEA EXOCYCLICA.

Suborder GNATHOSTOMATA.

Family CONOCLYPEIDÆ.

Genus CONOCLYPEUS, *Agassiz*, 1840 (amended).

(See *antea*, p. 51, Part ii.)

1. CONOCLYPEUS ALVEOLATUS, *Duncan & Sladen.* Plate XXIII, Figs. 1–6.

The test is of large size, marginal contour oval, slightly protruding posteriorly, the breadth being about eight ninths of the length. The height is nearly two thirds of the length, and the apical summit is rather excentric anteriorly. Seen in longitudinal profile, the dorsal convexity approaches a subconoid outline, but with the apex well rounded, and the anterior slope straighter and less curved than the posterior; the odd posterior interradium is also slightly tumid or subcarinate along its median line, approaching to a subrostrate prominence at the posterior extremity. The actinal surface is flat, very faintly impressed round the peristome, and the margin, though comparatively sharp, is well rounded.

The apical disk is large. There are four genital pores; and the whole of the extensive central portion of the system is punctured with the pores of the madreporite. The ocular plates and pores are exceedingly minute and do not encroach on the madreporiform body.

The ambulacral petals are broad and equal, very widely open at the outer extremity, and with no tendency to converge. The upper portion of each of the petals is sunken in a well-defined depression of the test, which gradually disappears, however, towards the outer fourth of the petal, where the interporiferous zone is flush with the rest of the test, the petals reaching almost to the margin. This depression of the ambulacral areas gives a very prominent and almost gibbous character to the interradial portions of the test on the upper portion of the abactinal surface. The poriferous zones are very broad, the width increasing gradually from the apex to the inner third of the petal, and then decreasing slowly up to the outer extremity. The outline formed by the outer series of pores in a petal is lanceolate and widest about the middle of the petal, and somewhat constricted, or less wide, at the outer extremity. The inner series of pores form straight lines, which open out or diverge gradually in an increasing degree from the apex to the extremity. The interporiferous area is consequently a wedge-shaped band, its width being equal to, or only very little greater than, the poriferous zone at the portion of the petal where this is widest; but the width of the area is doubled at the outer extremity of the petal. The pores of a pair are wide apart and united by a very conspicuous furrow, the outer pores being elongate and the inner pores round. The divisional costæ are but slightly broader than the grooves, and are ornamented with very minute granules, normally forming a single line, but frequently becoming irregular from crowding and diminution in size. The ornamentation of the interporiferous area is close and compact, uniform with that of the interradial areas, the tubercles being numerous. From the extremity of the petal the poriferous zone is continued by a series of single pores placed in well-defined depressions which converge from the ambitus to the peristome; and the interporiferous area is very deeply and rather suddenly troughed or depressed near the peristome, giving great prominence to the bourrelets. Just before this depression of the ambulacral area commences the pores fall into double series, although there is some irregularity in their position, and a few additional pores are sometimes present. The bourrelets are large and conspicuous, and are emphasized by the depression of the ambulacral areas above mentioned. The bourrelet of the odd posterior interradium is large and broader than the rest, whilst the two anterior bourrelets are slightly more elongate and prominent than the posterior. The tuberculation of the bourrelets is larger than that of the test generally, but the tubercles become smaller and more crowded on the sides of the bourrelets and on the peristomial margin. The peristome is subcentral, pentagonal, and very deeply incised.

The periproct is elongate, elliptical, encroaching almost as much on the margin as on the actinal surface, to the plane of which its position is oblique. The margins of the aperture are rather deeply and sharply rounded inward. An almost naked band, along which the intermediate miliary granulation is more or less confluent, occupies nearly the whole of the median line of the odd posterior interradium between the periproct and peristome.

The tuberculation of the test is small, uniform, crowded, and compact. The primary tubercles are small, equal-sized, sunken in deep scrobicules, so that the mamelon of the tubercle and the intermediate miliary space are on the same level. The scrobicules are equidistantly spaced, and the intermediate miliary space is less than, or at most only equal to, one half the diameter of the scrobicule. Although usually worn, there are some perforated and crenulated tubercles to be seen.

Remarks. This species differs from *Conoclypeus Sindensis*, nobis, from the Ranikot series, in its shape and the construction of the ambulacra; and from *C. Delanouei*, de Loriol, from Egypt, by the shape, by the width of the peristome, and by the width of the interporiferous areas.

Dimensions.

	millim.
Length of the test	92
Breadth of the test	81
Height of the test	57
Breadth of the petal at its widest part	13·5
„ „ „ outer extremity	9·5
Breadth of the poriferous zone at its widest part	3·75 to 4

Locality. In the Khirthar series. Surban range, south of Eri, north-east of Búla Khán's Thána. Survey-number $\frac{G\ 280}{60}$.

Illustrations of the Species in Plate XXIII.

Fig. 1. Abactinal view of the test: natural size.
2. Actinal view of the test: natural size.
3. Longitudinal profile of the test: natural size.
4. A bourrelet and rudimentary phyllode: magnified.
5. Terminal extremity of an ambulacral petal: magnified.
6. Apical disk: magnified.

2. CONOCLYPEUS PINGUIS, *Duncan & Sladen*. Plate XXIII, Figs. 7–11.

The test is large, subovoid in marginal outline, the greatest breadth being opposite the extremities of the antero-lateral petals. The breadth is rather more than nine tenths of the length, and the height is rather more than three fifths of the length. The apical centre is slightly excentric in front, and the longitudinal profile, which is subconoid in outline, shows the anterior to be more arched and tumid than the posterior curve, the odd posterior interradium being on a gentler slope and faintly subcarinate. The actinal surface, though flat generally, is slightly impressed around the peristome, and the margins of the test are well rounded, so that the intervening portion of the actinal surface becomes rather tumid in character.

The apical disk is of moderate size. The four genital pores are oval and very large, with the intermediate space occupied entirely by the madreporiform body, the surface of which is also subtubercular. The ocular plates slightly encroach on this body, and the optic pores are large and subtriangular or semicircular in shape.

The ambulacral petals are wide, flush with the test, and somewhat flexuous in their course; they are widely open at their outer extremity, which terminates somewhat abruptly at a little distance from the margin, and there is a faint tendency towards convergence. The poriferous zones are very wide, attaining their greatest breadth at about the middle of the petal; and the diminution of the breadth is neither great nor rapid towards the extremity, where they are comparatively broad. The interporiferous area is nearly twice as broad as the poriferous zone at its widest part. The pores of a pair are very wide apart and united by a deep furrow; the outer pore is elongate and slit-like, and the inner pore round or elongately oval. The divisional septum is ornamented with a single row of miliary granules. The ornamentation of the interporiferous area is uniform with that of the rest of the test, and is well spaced. The poriferous zones pass over the ambitus as a single series of pores, and these converge towards the peristome. On the inner third of the zone, the pores fall into double series, placed obliquely, but often irregularly, and with some additional pores. The inner extremity of the ambulacrum is depressed and forms a constricted trough down to the peristome, which greatly emphasizes the bourrelets. The bourrelets are very large and tumid, the two anterior being the broadest and most prominent, whilst the two posterior laterals are the most pointed and least prominent. In the neighbourhood of the bourrelets the tuberculation is larger than elsewhere, but becomes smaller and more crowded down the sides of the bourrelets and up to the margin of the peristome.

The peristome is large and slightly excentric in front. The periproct is elongate, elliptical, and entirely on the actinal surface, but close to the posterior margin of the test.

The tuberculation of the test is rather large and more widely spaced than in the preceding species, the intermediate miliary space being frequently greater than the diameter of the scrobicules, the depth of these being also less than in the previous form. On the actinal surface the tuberculation is larger and more crowded.

Remarks. This species is readily distinguished from its congeners by the plump well-rounded abactinal surface, by the great breadth of the ambulacra, and by the character of the ornamentation.

A fragmentary fossil of a small and badly-preserved test we refer with some hesitation to this species. The marginal contour is more rotundly oval; and the outline of the abactinal surface, as seen in longitudinal profile, shows the slopes to be somewhat less full and convex than in the type. As the other characters of the test accord sufficiently closely with the form now described, the differences may not improbably be attributable to age only.

Dimensions.

	millim.
Length of the test	94
Breadth of the test	80
Height of the test	56
Breadth of the petal at its widest part	15
" " outer extremity	11
Breadth of the poriferous zone at its widest part . . .	3·75

Localities. In the Khirthar series of strata:—i. Baili, west of Tóng. Survey-number $\frac{G\,304}{23}$.

ii. A young example, which we refer to this species, was presented to the Geological Survey; the exact locality was not known, but said to be near Kotri, probably the hills west of Kotri. Survey-number $\frac{G\,280}{144}$.

Illustrations of the Species in Plate XXIII.

Fig. 7. Abactinal view of the test: natural size.
8. Actinal view of the test: natural size.
9. Longitudinal profile of the test: natural size.
10. Terminal extremity of an ambulacral petal: magnified.
11. Apical disk: magnified.

3 CONOCLYPEUS ROSTRATUS, *Duncan & Sladen.* Plate XXIV, Figs. 1–4.

The test is of large size, with an elongately oval marginal contour, somewhat angular or protuberant in the lateral interradia, and with a comparatively prominent rostration posteriorly. The greatest breadth occurs in the postero-lateral interradia, and is about four fifths of the length. The anterior excentricity of the apical disk is very slight; and the greatest height of the test, which is about one half the length, is placed somewhat posterior to this. Seen in longitudinal profile the dorsal outline of the test is decidedly subconoidal, the anterior slope very slightly convex, and the posterior slope becoming tumid in the neighbourhood of the posterior rostration and terminating more or less precipitously. The outline of the transverse profile is well arched, and the margins of the test are gently rounded. The actinal surface is almost flat, slightly impressed around the peristome, and merging with a gentle slope into the curvature of the margin.

The ambulacral petals are broad, and each is situated in a faint but well-marked concavity of the test, which does not terminate abruptly, but extends laterally on to the interradial areas, dying out gradually. The petals remain widely open at their outer extremities and terminate abruptly before the margin is reached. The width of the petals is from $\frac{150}{1000}$ to $\frac{144}{1000}$ of the length of the test; and the width of the poriferous zone is very remarkable, being at its broadest part equal to, or even slightly greater than, the width of the interporiferous area, being 5 millim., or $\frac{1}{20}$ of the length of the test. The diminution in the width of the poriferous zone as it approaches the margin is comparatively slight, and the last two or three conjugate pores diverge at an angle from the horizontal, the divergence increasing gradually in each succeeding outward pair, and in this manner emphasize the abrupt termination of the poriferous zone. The width of the interporiferous area at the extremity of the petal is very slightly greater than at the widest part of the petal. The inner pores of the zone are round, and the outer pores elongate, the pores of each pair being united by a deep furrow. The costæ which divide the pairs are slightly wider than the furrows and are ornamented with a single line of small miliary granules, twelve to fifteen or more being present on each. The ornamentation of the interporiferous area is similar in character to that of the interradial areas, the primary tubercles being, however, rather more widely spaced.

Peristome and surrounding portions of the test are unknown. Periproct close to the posterior extremity, and (probably?) encroaching on the margin; but unfortunately the preservation of this part of the specimens at our disposal is unsatisfactory.

Remarks. A specimen which was not found in place, but is referred by the collectors to the same locality, we consider to belong to this species, although it presents some variation in form when compared with the type. The breadth is rather less in relation to the length, the marginal contour is more angular in the region of the anterior interradia, the posterior rostration is more produced, and the depressions in which the petals are placed are less marked than in the type. In all other points the correspondence is close; and we see no reason to separate the form from *C. rostratus*. A very much weathered specimen from Roïs Hill, south of Damaj, we also refer to this species, although not without reservation. The general form of the test is well preserved; but all detail on the abactinal surface is lost, hence definite comparison is impossible. The actinal surface is well preserved. The test is smaller than the type, its marginal contour is on the whole more regularly oval, and, from the general appearance of the fossil, we are led to believe that the ambulacral depressions were very faint.

Dimensions.

	a. millim.	b. millim.	c. millim.
Length of the test	100	96	87
Breadth of the test	83	74	72
Height of the test	48	53	45
Width of one of the paired petals . .	15	14·5	12·5 (?)

Localities. Khirthar series of strata:—i. Hills east of Trak. (Locally highest beds of the group.) Survey-number $\frac{G\,280}{57}$.

ii. Not found in place, but referred to the same locality. Survey-number $\frac{G\,280}{57}$.

iii. Roïs Hill (east flank), south of Damaj. Survey-number $\frac{G\,226}{106}$.

Illustrations of the Species in Plate XXIV.

Fig. 1. Abactinal view of the test: natural size.
2. Longitudinal profile of the test: natural size.
3. A portion of the left posterior ambulacral petal at its widest part: magnified.
4. Terminal extremity of the same petal: magnified.

4. CONOCLYPEUS GALERUS, *Duncan & Sladen*. Plate XXIV, Figs. 5–10.

Three fragmentary tests of a well-defined species of *Conoclypeus* occur in the collection of Khirthar fossils. Unfortunately none of the specimens are sufficiently well preserved for a complete description of the form to be given; but the following points are observable, and serve to mark the individuality of the species.

The test is large, with an elongately oval or oviform marginal contour. The greatest height is two thirds of the length, and is situated very far in front, which gives the test a conspicuous excentric conical form. Seen in longitudinal profile the anterior slope, which is very steep and precipitous, is comparatively flat and but little convex; it bends rather rapidly over on the rounded apex, and is gently curved at the acutely rounded margin. The posterior slope, although steep, exhibits a much greater incline than the anterior slope, and its flexure is remarkable; after proceeding a distance downward from the well-rounded apex the slope becomes flat, or even with a slight trace of concave inbending, and then gradually curves outward with a rather bold convexity or tumidity, and passes over on to the region of the slight posterior rostration with a precipitous curve. The posterior margin is acute. Seen in transverse profile, the sides of the test slope with a regular convex curve of great inclination.

The actinal surface appears to have been remarkably flat, with a slight depression towards the peristome.

Apical disk very excentric anteriorly, corresponding with the summit of the test. Structure wanting.

Ambulacra broad and long, extending close to the ambitus. The right anterior ambulacrum measures 14·5 millim. at its widest part, the interporiferous area being at this place 6·5 millim. in breadth, and the width of the poriferous zone here is consequently 4 millim. This great width is maintained for a considerable distance towards the apex, and the diminution in breadth is slight and very gradual until close to the summit. Below the point of greatest breadth the poriferous zone becomes much diminished in breadth, tapering all the way to the extremity, where the pores are not more than 1 millim. apart, whilst the interporiferous area is here 8·5 millim. across the ambulacra, which terminate without any curve. The inner pores are transversely oval; the outer pores long and slit-like, and are united by a straight deep furrow. The intervening costæ are rather flat and tabular, ornamented with numerous very minute granules, twelve to fourteen in a line, with additional small supplementary granules at the outer end, which break the regularity of the line and give the appearance of a small group, or even two or three lines near the junction of the costa with the neighbouring interradial area. Sometimes the additional granules are present along the whole costa, and the lineal character of the ornamentation is then obliterated; and sometimes only a few additional are present at the inner and the outer extremity of the costa alike.

The paired ambulacra are about equal in width, and the odd anterior one is a shade narrower. The antero-lateral petal is bent slightly forwards from midway outwards, the character being chiefly noticeable in the outline of the interporiferous area; and the postero-lateral petals are slightly sinuous, in conformity with the undulations of the posterior part of the test, the convexity, which attains its maximum about midway along the petal, being directed forwards. The posterior ambulacra come well backwards, and the posterior interradium is considerably narrower than the postero-lateral interradia; towards the extremity the posterior petals in passing downwards are slightly curved forwards. The ornamentation of the interporiferous area consists of small, widely spaced, primary tubercles sunken in small deep scrobicules, the wide intermediate spaces, which are greater than the diameter of the scrobicules, being covered with very small, definite, rather widely spaced, uniform, miliary granules. The ornamentation of the interradia is similar in every way excepting that in certain regions the primary tubercles are perhaps not quite so widely spaced. On the actinal surface the character is changed, the scrobicules being larger and the intermediate spaces narrow.

The peristome is slightly excentric in front: unfortunately the surrounding portions of the test are obscured in the specimens at our disposal. The structure of one of the posterior ambulacral areas is well preserved between the peristome and the margin; near the peristome there is a tendency to form a double row of pores—an appearance arising not so much from additional pores as from an alternate disposition of the normal pores through a slight alteration of their position on the plate; a few additional small intercalated plates, however, are present here and there. Near the margin the arrangement of the ambulacral plates recalls that found in *Amblypygus*—namely, one very small triangular intercalated plate inserted between two large ones at their outer margin, thus forming a triplet, which is succeeded by similar triplets, the small intercalated plates being consequently every third plate. Nearer the peristome, in the form under notice, the small intercalated plate is found between nearly every other large plate, and sometimes two intercalated plates may occur together.

The periproct is preserved in only one example. It is large, elongately oval, and narrow, with the greatest diameter corresponding with the longitudinal axis of the test; it is placed entirely on the flat actinal surface and comes up close to the margin. The major and minor diameters of the aperture measure 12 millim. and 6·5 millim. respectively.

Remarks. Although only fragmentary specimens of this species have been found, the form is well marked by the peculiar helmet-shaped outline of the test, by the character of the ambulacra, as well as by the character of the ornamentation. In none of the other Indian species are the primary tubercles so widely spaced.

Dimensions. The following measures are only approximate, as no entirely perfect specimen is contained in the collection:—

	a. millim.	*b.* millim.
Length of the test	about 90	about 95
Breadth of the test	„ 75	„ 77
Height of the test	„ 60	„ 50 (crushed).

Another specimen is too much damaged to permit of any measurements.

Localities. In the Khirthar series:—i. Dháran Pass (east side), near Laki. Survey-number $\frac{G\ 280}{66}$.

ii. Phitto, west side of the Dháran range. Survey-number $\frac{G\ 302}{105}$.

Illustrations of the Species in Plate XXIV.

Fig. 5. Abactinal view of a fragmentary test: natural size.

6. Longitudinal profile of the same specimen: natural size.

7. Longitudinal profile of another test: natural size.

8. A portion of an ambulacral petal at its widest part: magnified. (Same test as Figs. 5 and 6.)

9. Terminal extremity of the same petal: magnified.

10. Portion of an ambulacral area on the actinal surface, showing the arrangement of the ambulacral plates near the peristome: magnified.

Family CLYPEASTRIDÆ.

Subfamily EUCLYPEASTRIDÆ.

Genus ECHINOCYAMUS, *van Phelsum*, 1774.

Test of small size, more or less depressed, oval, oblong.

Ambulacral summit central; apical system compact, four generative pores, five ocular pores.

Ambulacra indistinct and scarcely petaloid, open at their extremity. Poriferous zones with few pores, arranged in widely spaced pairs. Pores of a pair round and not united by a conjugating furrow.

Interambulacral areas of the test supported internally by a pair of simple vertical partitions radiating from the margin toward the peristome.

Peristome central, subpentagonal, with high auricles internally.

Periproct oval or rounded, placed between the peristome and the posterior margin of the test.

1. Echinocyamus nummuliticus, *Duncan & Sladen.* Plate XXV, Figs. 14–20.

Form subdepressed, but rather high for the genus; marginal contour oval, slightly more contracted in front than behind. Abactinal area convex, almost subconoid, with the greatest height subcentral or slightly excentric in front; seen in longitudinal profile the posterior slope is somewhat straighter or less arched and less bombous than the anterior slope, and the anterior margin is thicker and more tumid than the posterior. The transverse profile is regularly convex, and its outline approaches the conoid. The actinal surface is flat, the margins of the area rounding gently on to the sides, which are well rounded. There are slight depressions along the median radial lines of the actinal surface, more distinct in some specimens than others, which give a somewhat undulating or faintly tumid character to the area.

The apical disk is very small, and the four genital pores are scarcely distinguishable from the tentacular pores of the ambulacra. The anterior pair are placed closer together than the posterior. Immediately between the anterior pair of pores is a rather smaller pore, which is probably the madreporic foramen. The ocular pores are exceedingly minute, and only visible under high magnification and careful illumination: that of the odd anterior radius is placed more outward than the madreporic pore, and stands at the apex of a triangle, almost equilateral, whose base would be represented by a line joining the anterior pair of genital pores. The anterior pair of ocular pores stand midway between the antero- and postero-lateral genital pores, but more distant from the centre, and are consequently wider apart than the anterior pair of genital pores. The posterior pair of ocular pores are placed behind the posterior pair of genital pores, that is to say further outward, away from the centre; they are, however, much nearer together than the posterior genital pores, being about the same distance apart as the anterior pair of genital pores.

The ambulacral petals are broad, short, subequal, and very rudimentary in character.

The poriferous zones are broad, and almost straight in their course after attaining the greatest breadth of the petal: hence the outline of the petals is very slightly petaloid.

The pores are round, equal, or with the outer pores of a zone slightly largest, the pores of a pair being wide apart and with no trace of conjugation. The pairs of pores are distinct from one another, and there are not more than seven or eight in each zone. The pairs of pores are slightly oblique, and the amount of obliquity increases in each plate towards the outer extremity of the poriferous zone, the outer pore of the last pair being often brought down till nearly in vertical series with the inner pores of the zone. The inner pores of the companion zones of a petal form vertical series parallel with one another, and the interporiferous area is consequently of uniform width; it is narrower than the breadth of the poriferous zone at its widest part; and in some specimens the surface of the interporiferous area appears to be faintly keeled, or slightly higher than the interradial portions of the test.

The peristome is central, pentagonal, and with the margin concavely bevelled out of the thickness of the test. The depth of this bevelled margin is somewhat emphasized by the presence of a slightly elevated ridge round the outer or external edge of the bevel. Owing to the breadth of the bevel, the diameter of the inner pentagon or actual margin of the peristome is very little more than one half that of the outer margin. The sunken edge is ornamented with small miliary tubercles, sunken in small scrobicules and irregularly placed; and there are a pair of conspicuous, elongately oval, buccal or peristomic pores corresponding to each ambulacrum, the pores of a pair being close together and only separated by a thin dissepiment. There are two small granule-like protuberances, situated above the buccal pores, projecting from the peristomial margin.

The periproct is elongately oval, placed longitudinally and at about midway between the margin and the peristome. The length is twice the breadth, and the length is about the same as the diameter of the inner margin of the peristome.

The tuberculation of the test is minute, and consists of small primary tubercles sunken in deep scrobicules irregularly distributed over the surface, the intermediate spaces being occupied by comparatively large-sized miliary granules, more or less irregular in their size, development, and prominence.

Remarks. The high and broadly oval form of the test and the character of the ambulacra appear to separate this variable form distinctly from any Nummulitic species with which we are acquainted.

Dimensions. The length of the test is 7 millim., the breadth 6·5 millim., and the height 4·25 millim.

Localities. In the Khirthar series of strata:—i. Súmbak Hill, south-west of the Vero plain. Survey-number $\frac{G\,226}{132}$.

ii. East of Band Vero, north-west of Kotri. Survey-number $\frac{G\,226}{151}$.

iii. On the road about four miles west of Kotri. Survey-number $\frac{G\,226}{147}$. (One imbedded specimen, scarcely determinable.)

iv. Near Petiáni, ten miles west of Kotri. Survey-number $\frac{G\,280}{77}$. We were at first inclined to place the three very small specimens from this locality as a separate variety, on account of their greater rotundity and more depressed form; but, taking into consideration the great variability of the species and the scanty material, we prefer to place them along with the type, recording at the same time this note.

Illustrations of the Species in Plate XXV.

Fig. 14. Abactinal view of the test: natural size.
15. The same: magnified.
16. Actinal view of the test: magnified.
17. Longitudinal profile of the test: magnified.
18. Transverse profile of the test: magnified.
19. Apical disk and surrounding portions of the test: magnified.
20. Peristome and surrounding portions of the test: magnified.

Variations. A large series of specimens of *Echinocyamus* are comprised in the collections from the Khirthar series, and were obtained from several localities. Considerable variation occurs in the shape of the test, and this is found in a series of specimens from the same locality, and appears to be irrespective of age or size. The variation chiefly affects the marginal contour, which may be more oval and elongate or more circular than the type form; and the test may also be more depressed and less subconoid in its dorsal convexity. In fact the species seems to be as protean in its form as the living representative; and it can readily be understood that a collector, having only a few specimens at his disposal, might be led to consider that he was dealing with several species if form alone were his guide.

The following variations, each from different localities, appear to us to be worthy of more than passing mention; and although in some instances the number of examples is only small, they seem to be well marked and characteristic. Even in these cases, however, it is not without hesitation that we rank them as nominal varieties, after the experience above recorded; for the number of specimens is not sufficient to thoroughly gauge the value of the variations. In our present state of knowledge we are disposed to consider that they present a locational character—an opinion, however, which can only be offered with reserve until a larger quantity of material is available for study from each locality; for it is unquestionable that amongst a large series of the normal or typical form there appear to be *near approaches* to the varietal forms; whilst similar approximations to the type form are found to exist, in more than one instance, where a tolerable series of the variety is available.

2. Echinocyamus nummuliticus, var. obesus. Plate XXV, Figs. 21–24.

The contour of the margin is more regularly ovoid. The test is relatively much higher, the longitudinal profile is more regularly arched, and the sides are more tumid and rounded off imperceptibly on to the actinal surface. The examples of this variety are all small, the length of the largest being 7 millim., and that of the smallest 4 millim. In similar sized specimens of the type form of the species the test is much more depressed and flatter than in the large and fully grown specimens; whilst in the variety under notice these characters are reversed.

Locality. In the Khirthar series of strata. Near the gorge of the Báran river, north-east of Búla Khán's Thána. Survey-number $\frac{G\ 226}{114}$.

Illustrations of the Variety in Plate XXV.

Fig. 21. Abactinal view of the test: natural size.
22. The same: magnified.
23. Actinal view of the test: magnified.
24. Longitudinal profile of the test: magnified.

3. Echinocyamus nummuliticus, var. oviformis. Plate XXV, Figs. 25–28.

The marginal outline of this variety is oval, and the test is regularly convex both on the abactinal and actinal surfaces, resembling the shape of *Fibularia* very closely. The sides are very tumid, there is no flattening of the actinal surface, and the test is very faintly impressed round the peristome.

Localities. In the Khirthar series:—i. East of Band Vero, north-west of Kotri. Survey-number $\frac{G\ 226}{151}$.

ii. Twenty-four miles west of Kotri (entering the hills on the road to Búla Khán's Thána). Survey-number $\frac{G\ 200}{72}$.

Illustrations of the Variety in Plate XXV.

Fig. 25. Abactinal view of the test: natural size.
26. The same: magnified.
27. Actinal view of the test: magnified.
28. Longitudinal profile of the test: magnified.

4. Echinocyamus nummuliticus, var. planus. Plate XXV, Figs. 29–32.

The test is low and depressed, elongate and pentagonal, and the abactinal surface is very slightly convex. The actinal surface is more or less plane, but well rounded on to the sides, and there is a subrostral prominence anteriorly, and a slight concavity of the whole surface occurs, running transversely through the peristome. Length of test 7·5 millim.

Locality. In the Khirthar series of strata. Twenty-four miles west of Kotri (entering the hills on the road to Búla Khán's Thána). Survey-number $\frac{G\ 280}{72}$.

Illustrations of the Variety in Plate XXV.

Fig. 29. Abactinal view of the test: natural size.
30. The same: magnified.
31. Actinal view of the test: magnified.
32. Longitudinal profile of the test: magnified.

5. Echinocyamus rotundus, *Duncan & Sladen.* Plate XXV, Figs. 33–37.

There is a solitary specimen which we are unable to refer to any previously known form of *Echinocyamus*; and although it is difficult to make out some of the details of structure as thoroughly as might be desired, the general characters appear to be so well marked and distinctive that we feel obliged to regard it as an independent species. No other Clypeastroids were obtained from the same locality.

The size of the specimen is large for the genus; the marginal contour of the test is almost circular, slightly protruding posteriorly. The longitudinal profile is almost regularly convex, but slightly more tumid anteriorly than posteriorly; the transverse profile is regularly convex, with no tendency to a subconical form, and the height of the test is not great. The margin is well and evenly rounded, passing over imperceptibly to the actinal surface, which is somewhat flattened; and there is scarcely any impression around the peristome.

The apical disk is small and central; and the four genital pores are large and occupy nearly the whole of the genital plates. The anterior pair of plates are placed close together; and the madreporic puncture, instead of being situate between them as in the preceding species, is pushed forward towards the middle of the system. The ocular plates are exceedingly minute, and fit in at the outer portion of the juncture of the genital plates. The posterior pair of genital plates are wider apart than the anterior pair, and their distance apart is greater than that separating an anterior from a posterior pore on the same side.

The ambulacral petals are comparatively long and rather more developed in character than usual in *Echinocyamus*. The poriferous zones are straight and diverge as they proceed outward; this character is most marked in the odd anterior ambulacrum, which is much wider than the paired petals. In this petal the interporiferous area is three, or even more, times the width of the poriferous zone and wedge-shaped in outline; but in the paired petals the interporiferous area is only a little wider than the poriferous zone. The interporiferous area is perfectly flush with the level of the test, and there is no tendency to form a keel. The pores are equal or subequal, and faintly elliptical and placed oblique, and the pores of a pair are almost equidistant throughout the ray, and there is no trace of conjugation whatever between the pores. There are ten or eleven pairs of pores in the odd anterior petal, and nine or ten in the paired petals, with one or two single pores in each.

The peristome is pentagonal and very slightly excentric posteriorly, only a shade removed from the subcentral position. The periproct is small and elongately oval, rather nearer to the peristome than the posterior margin. No further details respecting these structures can be made out, in consequence of the manner in which the test is preserved.

The tuberculation of the test is minute and uniform. The primary tubercles are sunken in scrobicules, and more numerous and crowded than in the preceding species; and the interspaces are consequently smaller and more homogeneous in character.

Dimensions.

	millim.
Length of the test	9
Breadth of the test	8·75
Height of the test	5

Locality. In the Khirthar series of strata. North by east of Meting. Survey number $\frac{G\ 280}{98}$.

Illustrations of the Species in Plate XXV.

Fig. 33. Abactinal view of the test: natural size.
34. Abactinal view of the test: magnified four times.
35. Actinal view: magnified four times.
36. Longitudinal profile: magnified four times.
37. Apical disk: magnified.

Genus SISMONDIA, *Desor*, 1857.

Test of small or medium size, subpentagonal or ovoid, depressed, inflated at the margin.

Ambulacral summit central or subcentral; apical system compact, four generative pores.

Ambulacra petaloid, usually long, and more or less open at their extremity. Pores united by a conjugating furrow. Interambulacral areas of the test supported internally by a pair of strong, complex, vertical partitions.

Peristome central, sometimes impressed.

Periproct rounded, placed between the peristome and the margin.

Prior to the establishment of this genus by Desor, the species included therein had usually been placed in the genus *Echinocyamus*. *Sismondia* is distinguished by the form of the test, by the well-developed petaloid ambulacra, by the conjugate pores, and by the greater development of the internal partitions.

1. Sismondia polymorpha, *Duncan & Sladen*. Plate XXV, Figs. 1–13.

Form depressed, marginal contour subovoid, with a tendency towards the pentagonal, the outline being slightly contracted anteriorly and feebly truncate posteriorly. Abactinal area almost plane, excepting the costulate interporiferous areas of the petals. The height of the test is small and is rather less posteriorly than anteriorly, the abactinal surface sloping slightly from the apical centre of the disk to the posterior extremity. The margin is thick and well rounded, almost tumid. The actinal surface is slightly concave, the test being regularly and evenly depressed around the peristome.

The apical system is subcentral or very slightly excentric in front. The apical disk is flush with the test and comparatively broad. There are four large genital plates all touching one another; the genital pores are large and round, and the anterior pores are much nearer together than the posterior. There is no true madreporiform body, but a single, round, madreporic pore is present, situated rather nearer to the right anterior generative pore than the centre of the apical system. The ocular plates are very small and somewhat escutcheon-shaped, with the apex directed away from the disk; and they occupy a place at the junction of two neighbouring genital plates. The ocular pits are minute and elongate or slit-like; and in well-grown specimens the portion of the plate on the outer side of the pit away from the centre is somewhat elevated, and forms a slightly raised embankment round the aperture.

The ambulacral petals are broad, subequal, equal in length to two thirds of the distance between the apex and the margin; widely open at the extremity, where the poriferous zones are slightly bent outward. The poriferous zones are equal; the pores are round, the pairs slightly oblique, and the conjugation scarcely perceptible. The pores of a pair are wider apart at the inner third of the zone and approximate gradually as they proceed outward, and rapidly towards the apex—a structure which emphasizes the marked and graceful petaloid curve of the zones. There are about twelve pairs of pores in each zone. The interporiferous area of the petal is sublanceolate in outline and very broad, equal in width to more than twice that of the poriferous zone at the widest part. The interporiferous area within the petal is costulate or tumid—a feature usually more marked in the posterior pair of petals than in the other three. The posterior petals are more disticntly petaloid in outline, in consequence of the poriferous zones visibly curving inward and reducing the breadth of the interporiferous area towards the extremity of the petal. In the three anterior petals the inner series of pores, after attaining the place of the greatest breadth of the petal, form an almost straight line, and the interporiferous area is consequently little, if at all, contracted towards the outward extremity of the petal. The anterior odd petal is slightly smaller than the others.

There are no large pores in continuation of the petal-series visible on the actinal surface, but in their place a very great number of minute and closely crowded foramina occupy the whole of the horizontal sutures between the ambulacral plates and also the vertical sutures along the line of junction of the ambulacral and interambulacral plates, the horizontal series being much more crowded and numerous close to the peristome.

The peristome is central, subdecagonal, and with the margin bevelled inward. The pair of buccal or peristomial pores which open into the peristomial margin of each ambulacrum are conspicuous but closely placed; and there is a slight, tubercular, roof-like development over each pair. The periproct is circular, nearly two thirds the diameter of the peristome, and is situated nearer to the margin than midway between the peristome and the posterior extremity. The tuberculation of the test is minute, sunken in deep scrobicules, and rather widely spaced.

Variations. Considerable variation occurs within certain limits in the shape of the marginal outline of the test; and these changes of form are found to be altogether irrespective of size or age when a large series of specimens is examined, such as that furnished by the present collection. The contour may assume almost any form between an elongate ovoid, similar to that usually presented by the small existing species of *Echinocyamus* (*E. pusillus*), and the ovoid pentagonal test characteristic of such living urchins as *Clypeaster subdepressus.*

Remarks. This species presents some alliance to *Sismondia Sæmanni*, de Loriol, from the Nummulitic of Egypt, but appears to differ in the more pentagonal outline, the more inflated margin, the wider and more open petals, and probably also in the character of the costulation of the interporiferous areas.

A variety, var. *sufflata*, nobis, occurs in the Nummulitic of Kachh.

Dimensions. The largest specimen measures 11 millim. in length, 10 millim. in breadth, and about 3 millim. in height.

Others measure 10·0 millim. long, 9·00 millim. broad, and about 2·75 high.
9·3 ,, 8·25 ,, ,, 3·00 ,,
7·0 ,, 5·50 ,, ,, 2·00 ,,

Locality. In the Khirthar series of strata; three or four miles south of Trak Hill. Survey-number $\frac{G\ 302}{124\ e}$.

Illustrations of the Species in Plate XXV.

Figs. 1–8. Abactinal view of a series of specimens, to show the variations of the marginal outline: natural size.
9. Abactinal view of the test of the same specimen as Fig. 8: magnified 2½ times.
10. Actinal view of the same specimen: magnified 2½ times.
11. Longitudinal profile of the same specimen: magnified 2½ times.
12. Apical disk and surrounding portions of the test: magnified.
13. Peristome and surrounding portions of the test: magnified.

Suborder ATELOSTOMATA.

Family CASSIDULIDÆ.

Subfamily ECHINONEINÆ.

Genus AMBLYPYGUS, *Agassiz*, 1840.

Test of large size; marginal contour subcircular or ovoid, more or less convex above and concave beneath, with thick margins.

Apical summit subcentral. Apical disk small and compact; four generative and five ocular pores; the madreporiform body occupying the whole of the central portion.

Ambulacra petaloid, widely open at the outer extremity, reaching nearly to the margin. Poriferous zones with the inner pores round and the outer pores elongate, the pairs united by a conjugating furrow. The extrapetaloid ambulacral plates are each punctured by a pair of very minute pores, placed diagonally and close together; and this extrapetaloid portion of the poriferous zone forms a straight, narrow, simple line of pores, often scarcely visible at the margin, extending to the peristome.

Peristome subcentral, oblique, subpentagonal, with irregular sides.

Periproct very large, oval or pyriform, with the major diameter in the direction of the longitudinal axis of the test, situated between the peristome and the posterior margin. Ornamentation very homogeneous. Tubercles very small, crenulate and perforate, placed in scrobicules uniformly distributed over the surface of the test, the intermediate space being occupied by fine miliary granulation.

This genus is nearly related to *Echinoneus*, as we have shown in the "Description of the Fossil Echinoidea of Kachh and Kattywar" (Pal. Ind. ser. xiv.). The oblique peristome, the size and position of the periproct, and especially the structure of the ambulacral plates, with the continuous series of double pores, indicate unquestionably a much closer alliance than has hitherto been recognized between the two genera. In the work just noticed we have discussed at length the various species hitherto included in the genus *Amblypygus*. The species from Kachh, along with the present series from Sind, constitute a remarkable assemblage of forms.

1. **Amblypygus subrotundus**, *Duncan & Sladen.* Plate XXVI, Figs. 1–14.

Test subdepressed; marginal contour subcircular, the length exceeding the breadth in a very slight but variable degree. The height is less than one half the breadth, and proportional to the length as 0·41 : 1, the dorsal surface being regularly convex, and the margins thick and well rounded. The anterior slope of the longitudinal profile is straighter and more inclined than the posterior portion of the profile, which is more arched and bombous, the test being thicker and more bombous in the area comprised by the three posterior interradia than anteriorly; this character faintly presents its greatest development along the median line of the odd posterior interradium, but the whole test is so evenly rounded that no definite carination is produced. The outline of the transverse profile is a regular, gentle, convex curve, with no tendency towards a conoid form. The actinal surface is subconcave, with the peristome rather deeply sunken and the surrounding portion of the test bombous, having a convex curve, which forms a gently rounded continuation of the almost inflated margin. On the ventral surface of some specimens there is a faint development of tumidity in each of the columns of plates of the interradia, the feature being most definite in the odd posterior interradium, where it produces the appearance of a very faint wide groove, passing from the periproct towards the margin.

The apical disk is slightly excentric in front, being distant from the posterior extremity $\frac{55}{100}$ of the entire length of the test. The generative pores, which are four in number, are very large and slightly oval in shape, occupying nearly the whole of their plate; the anterior pair smaller and nearer together than the posterior pair. The generative plates are all separated by prolongations of the central madreporiform portion of the disk, which is in connexion with the right anterior generative plate, the central portion being subcruciform in shape. The ocular plates are very small and subpentagonal in shape, a straight base being apposed to the extension of the central mass which separates the neighbouring generative plates. The two posterior ocular plates do not touch, although no portion of the central plate extends beyond their base-line.

The ambulacra are flush with the surface of the test, or with the poriferous zones very faintly sunken; they are moderately wide, and the petaloid portion extends quite to the ambitus. The posterior pair are rather wider than the anterior pair, and these again are rather wider than the odd anterior petal, which is the narrowest.

The series of pairs of pores extends uninterruptedly from apex to peristome, the inner pores forming a straight continuous line; the two lines thus formed by the companion zones of a petal diverge from one another gradually as they proceed from the apex, and converge again slightly on the ventral surface as they approach the peristome. On the upper portion of the ambulacra (the petaloid part) the poriferous zones are wide, the pores being wide apart and conjugate, having the inner pore round and the outer one elongate and connected by a furrow. The intervening dissepiment is rather broad, and is ornamented with a single line of small miliary granules. The outline formed by the petal is lanceolate, and the widest part is at about two thirds of the distance from the apex to the margin. The widest part of the poriferous zone is nearer the apex, nearly midway between the margin and the apex; at this point the poriferous zone is

¼ of the width of the interporiferous area, and thence the width of the poriferous zone decreases gradually to the margin. The widest part of the interporiferous area is at the margin, where it is slightly wider than twice the width of the poriferous zone at its widest part. The petaloid portion of the poriferous zone passes gradually and almost imperceptibly into the extrapetalous part, the pairs of pores being continuous throughout. In the extrapetalous part of the area both pores are small and round, and separated only by a very narrow dissepiment; and the pairs are placed oblique, their distance apart and the angle of obliquity to the horizontal increasing as they approach the peristome.

The structure of the ambulacra is interesting, for, notwithstanding the strict uniserial character of the poriferous zone, the poriferous plates are distinctly divisible into triplets, this arrangement being regular and invariable in the petaloid and in the extrapetaloid parts of the zone alike. Throughout the whole zone a smaller plate is intercalated between two larger plates, and of these the adoral is always slightly the largest. The small intercalated plate is only just large enough for its pair of pores, and scarcely extends into the interporiferous area. In the petaloid part of the zone the small plate is long and narrow (fig. 6), and in the extrapetaloid part it is almost equilaterally subtriangular (fig. 7). On the actinal portion of the test the large poriferous plates are much deeper (*i.e.* longer), and consequently the pairs of pores are wider apart (fig. 8). In the petaloid portion of the zone the inner pore is marginal, indenting the adoral edge of its plate: in the extrapetalous portion both pores are within their plate, and equidistant from the ad- and aboral margins. Reference to the figures of these different parts of the poriferous zone will give a better idea of the arrangement of the plates and pores than a lengthy verbal description.

The ornamentation of the interradial portions of the test consists of a great number of small, uniform, equidistantly spaced primary tubercles, faintly crenulated, and with a small perforated mamelon, placed in a shallow scrobicule, surrounded by a rim of small, uniform, distinct miliary granules. Occasionally the single ring of granules which separates neighbouring scrobicules is augmented by additional granules, and a few extra ones fill up the interspaces. At the margin the primary tubercles are rather more crowded, and on the actinal surface they are a shade larger. The ornamentation of the interporiferous areas is precisely similar to that of the interradia.

The peristome is slightly excentric in front, and placed in a well-developed depression of the test; it is large, subpentagonally oblong in form, and oblique in position, the longer axis being directed towards the right anterior interradium.

The periproct is very large, and occupies more than half the area between the peristome and the margin; it is longitudinally elongate and subpyriform, and its length is fully one third more than the greater diameter of the peristome. The contracted portion of the pyriform aperture is directed towards the peristome, and the distance of this extremity from the peristome is usually less than that which intervenes between the aboral margin of the periproct and the margin of the test.

Variations. The chief modifications, distinct from those dependent on growth, which may be noticed in the material at our disposal are as follows:—(1) a slight increase in the relative proportion of length to breadth; (2) a greater uniformity in the curvature of the anterior and posterior slope of the longitudinal profile, arising from the comparatively less tumid character of the posterior portion of the test—this variation being accompanied, in specimens from localities ii. and iii. (Survey-numbers $\frac{G\,302}{121}$ and $\frac{G\,302}{122}$), by a slightly greater prominence along the median line of the posterior odd interradium, amounting almost to a faint rostration at the posterior margin.

The greatest amount of modification from the normal type occurs in specimens from locality ix. (Survey-number $\frac{G\,280}{66}$). This form appears so well marked that we propose to distinguish it nominally as var. *conicus*. It differs from the typical *A. subrotundus* in the following points:—The proportion of the length to the breadth is greater than in the type, the apex is proportionately higher, and the anterior portion of the marginal contour is more contracted and less bombous in the area circumscribed by the anterior interradia. Seen in longitudinal profile, both the posterior and the anterior slope form much steeper declivities, the curvature of the posterior being only very slightly more bombous than the anterior one. From this it will be seen that the test has a subconoidal appearance. The margins are less thick, the distance between the periproct and the peristome is perhaps greater than usual, and the position of the peristome more excentric, whilst that of the apical disk is subcentral. Unfortunately the specimens are much weathered on the abactinal surface, and not well preserved.

Along with the above notices of variations, mention should also be made of two examples which we find amongst a series of small (young) specimens. The tests are unquestionably immature, but differ from the others in the higher and conoidal character of the dorsal area, in the margin being less thick and tumid, and in the peculiar subpentagonal marginal contour, expanded opposite the anterior petals, and contracted posteriorly, where the odd interradium is subrostrate. Possibly this may prove to be the young of a different species; but for the present we do not feel justified in drawing any definite conclusions, in consideration of the immature state of the specimens.

There are also portions of three or four tests from locality viii. (Eri Hill, Survey-number $\frac{G\,302}{110}$) which are only referred to this species with considerable hesitation; they may possibly belong to a distinct form. The fragments are well preserved, but are insufficient for positive determination.

Premature Form. In young specimens of 40 millim. length the test is suboval in outline, with very thick margins and an almost regular convex dorsal area, which is generally higher over the whole surface than in the adult—the height at the apex being proportional to the length as 0·50 : 1. The ambulacral petals are well developed and present the characters of the mature form. With increasing age and size, the height does not increase proportionately with the other dimensions of the test, and the margins become also relatively less thick. In a specimen 58 millim. long the regular convex curve of the dorsal surface, the strikingly pulvinate character of the actinal area, and the thick tumid margins are very characteristic. In this specimen the proportion of length to height is as 1 : 0·43. It is not until the test is fully grown that the almost circular form of the marginal outline is attained, and the posterior portion of the test becomes more tumid and generally higher than the anterior part.

From these observations we may deduce that in the young stages of *Amblypygus subrotundus* the test is more elongate, higher, with thicker margins and uniformly convex dorsal surface, and that these modifications produce a stout, elliptical form, very different in general character from that possessed by the mature animal.

Remarks. This species approaches *A. dilatatus*, Agassiz, but is distinguished from that form by the general rotundity of the test, its greater height, and the higher and more tumid character of the posterior portion; the margins are proportionally thicker and more tumid, the poriferous zones appear to be wider, and the actinal portion of the zone is not sunken in a furrow. The periproct differs somewhat in shape, being more pyriform, and is further removed from the posterior margin. The apical system is perhaps rather more excentric.

Dimensions.

Type specimen from locality i. (Survey-number $\frac{G\ 226}{103}$):—

	millim.
Length of the test	80
Breadth of the test	76
Height of the test	32
From centre of apical disk to posterior extremity	44
„ „ „ anterior extremity	36
Greatest width of the poriferous zone	2·75
Width of the interporiferous area at the above place	4·25
„ „ „ at the margin	6
Greatest width of the postero-lateral petal	10·75
„ „ antero-lateral petal	9·70
„ „ odd anterior petal	8·80

The proportion of length to breadth = 1 : 0·95.
„ „ to height = 1 : 0·40.

Other specimens measure:—

	Length in millim.	Breadth		Height		Locality.
		in millim.	Proportion to length = 1.	in millim.	Proportion to length = 1.	
	90	84	0·933	31	0·344	ii.
	76	68	0·894	29	0·389	ii.
	74	68	0·918	28	0·378	iii.
	71 +	66	0·929	27·5	0·387	v.
	66	60	0·909	27	0·409	v.
	64	?	...	27	0·421	iii.
	58	52	0·896	25	0·431	vii.
	42	37	0·880	20·5	0·488	vi.
	40	35	0·875	20	0·500	vi.
var. *conicus*	80	71	0·887	33	0·412	ix.
	72	67	0·930	30·5	0·423	ix.

Localities.

In the Khirthar series of strata:—

i. River-section east of Trak. Survey-number $\frac{G\,226}{103}$.

ii. Hilly ground south-east of Trak Hill. Survey-number $\frac{G\,302}{122}$.

iii. Kúní range, east of Trak. Survey-number $\frac{G\,303}{121}$.

iv. North-east of Kale-ka-Kúa, seven miles south-east of Trak. Survey-number $\frac{G\,302}{127}$.

v. Exact locality not known; said to be near Kotri, probably the hills west of Kotri. Survey-number $\frac{G\,280}{144}$.

vi. Twenty-four miles west of Kotri (entering the hills on the road to Búla Khán's Thána). Survey-number $\frac{G\,280}{72}$.

vii. Gorge of the Báran river, north-east of Búla Khán's Thána. Survey-number $\frac{G\,280}{71}$.

viii. Eri Hill (south-west side), Súmbak range. Survey-number $\frac{G\,302}{110}$.

Variety *conicus*:

ix. Dháran Pass (east side), near Laki. Survey-number $\frac{G\,280}{66}$.

Illustrations of the Species in Plate XXVI.

Fig. 1. Abactinal view of the test: natural size.
2. Actinal view of the test: natural size.
3. Longitudinal profile of the test: natural size.
4. Apical disk, from another specimen, slightly weather-worn: magnified.
5. Portion of the actinal surface of the same specimen: magnified.
6. Arrangement of the ambulacral plates near the middle of a petal: magnified.
7. Arrangement of the ambulacral plates near the ambitus: magnified.
8. Arrangement of the ambulacral plates on the actinal surface, midway between the peristome and the margin: magnified.
9. Abactinal view of the test of a young specimen, measuring 40 millim. in length: natural size.
10. Longitudinal profile of the same specimen: natural size.
11. Abactinal view of the test of a young specimen, measuring 58 millim. in length: natural size.
12. Actinal view of the same specimen: natural size.
13. Longitudinal profile of the same: natural size.
14. Variety *conicus*. Longitudinal profile: natural size.

2. Amblypygus patellæformis, *Duncan & Sladen*. Plate XXVII, Figs. 1–3.

Test subdepressed, marginal contour subovoid, the length being distinctly greater than the breadth, regularly rounded in front, and contracting along the sides towards the posterior extremity, where a faint trace of rostration is produced. The height is less than one half the breadth, and is proportional to the length as 0·33 : 1. The dorsal surface is regularly convex, and the margins are not particularly thick or tumid, the curvature of the dorsal area being more arched and continuing nearer to the ambitus than in *A. subrotundus*. In the longitudinal profile of the test the posterior and the anterior slopes are nearly equal in curvature, the latter, however, being slightly more tumid. The transverse profile shows a regular and well-developed convexity, merging into the comparatively thin, rounded margin. The actinal surface is almost flat, and has nothing of the pulvinate character usual in the species of this genus, the flatness terminating with only a comparatively slight and abrupt rounding at the extreme margin. There is a slight depression towards the peristome, but unfortunately that portion of the test and its immediate neighbourhood is concealed by a mass of matrix.

The apical disk is slightly excentric in front; but nothing can be said about its structure, owing to the destruction and obliteration of this part in both the specimens we possess. Indeed the whole of the abactinal area is in such a bad state of preservation that only the general features can be indicated.

The ambulacra are flush with the surface of the test, and the poriferous zones contract somewhat rapidly after attaining the maximum width, the petaloid portion thus appearing to terminate a little before the margin is reached. The outer line of the posterior poriferous zone in both pairs of petals is somewhat more curved than the companion zone; and in the posterior ambulacra the whole petal is slightly bent forwards (*i. e.* away from the posterior extremity) before passing over the margin, the curve being very marked when the interporiferous area is examined independently. The posterior pair of petals are rather wider than the anterior petals. The widest part of the poriferous zone is situated rather nearer the outer than the apical extremity of the petal, and at this point the poriferous zone is $\frac{9}{16}$ of the width of the interporiferous area, and thence the decrease in the width of the zone takes place rather rapidly. The greatest width of the petal is situated a little nearer the extremity of the petal than the point of greatest poriferous width. The widest part of the interporiferous area is at the margin, where it is slightly greater than twice the width of the poriferous zone at its widest part.

The ornamentation of the dorsal surface is almost entirely destroyed; and the traces that remain are so faint that it is impossible to make any useful observations in this direction. On the actinal surface the primary tubercles are smaller and more widely spaced than in *A. subrotundus*, and are surrounded by simple rings of miliary granules, which appear to stand somewhat isolated and distinct, in consequence of the intermediate spaces being unoccupied by granules.

The whole of the peristome and a portion of the periproct are concealed by matrix. The periproct is elongate and pyriform, the aboral margin being well rounded. The aperture is 14 millim. long and 7·5 millim. broad, and its aboral extremity is not more than 5 to 6 millim. distant from the extreme margin.

Remarks. This species is distinguished from its Indian congeners by the flatness of the actinal area, the comparatively thin and angular margin, and the well and uniformly arched dorsal surface; it is further characterized by the curve of the posterior petals, the subrostrate form of the posterior extremity, and perhaps also by the smaller and scantier primary tuberculation. When compared with a specimen of *A. subrotundus* of precisely similar size, these differences are very striking; they also appear to be sufficient to distinguish the species from the other known members of the genus.

Dimensions of type specimen.

	millim.
Length of the test	60
Breadth of the test	55
Height of the test	20
Greatest width of the poriferous zone	2·25
Width of the interporiferous area at the above place	4
" " " at the margin	5·5
Greatest width of the postero-lateral petal	8·75
" " anterior petals	8

The proportion of length to breadth = 1 : 0·916.
The proportion of length to height = 1 : 0·333.

Locality. Khirthar series of strata. Hilly ground south-east of Trak Hill. Survey-number $\frac{G\,302}{122}$.

We also refer to this species a second specimen found at Roïs Hill, near Damaj, south of Búla Khán (Khirthar series). Survey-number $\frac{G\,302}{119}$.

Illustrations of the Species in Plate XXVII.

Fig. 1. Abactinal view of the test: natural size.
2. Actinal view of the test: natural size.
3. Longitudinal profile of the test: natural size.

3. AMBLYPYGUS TUMIDUS, *Duncan & Sladen*. Plate XXVII, Figs. 4–6.

There is a test of a fine species of *Amblypygus* from the Khirthar series, but which unfortunately is so much obscured with matrix and otherwise badly preserved that only a partial description can be given. The test is high, with marginal contour subovoid, the greatest breadth being a little behind the anterior ambulacra, and the curve of the outline being sharper and more contracted posteriorly than anteriorly. The height is greater than half the breadth, and proportional to the length as 0·52 : 1, and the margins are thick and tumid. The curvature of the anterior slope of the longitudinal profile is less bombous than the posterior; and the posterior part of the test, as a whole, is thicker (higher) than the anterior. The transvere profile of the test shows a uniform convex curve of fair elevation. The actinal surface has a bombous aspect, and appears to have a very slight central concavity. The ambital margin does not at all overhang, but is bevelled away and well rounded.

The apical disk is concealed by matrix, but is probably central, or only very slightly excentric in front.

The ambulacra are flush with the surface of the test and lanceolate in outline; and the two lines of inner pores are straight, and converge gradually from the ambitus to the apex. The greatest width is at about two thirds the distance from the apex to the margin, the broadest part of the poriferous zone being somewhat nearer the apex; from this point of greatest breadth the poriferous zone contracts gradually until the margin is reached, the petaloid portion extending almost to the ambitus. The poriferous zone at its broadest part is five eighths of the width of the interporiferous area. The interporiferous zone is widest at the margin, and is there a little more than twice the width of the broadest part of the poriferous zone. The conjugate pores of the petaloid portion of the ambulacra are united by a well-defined furrow, and adjoining pairs are separated by a rather narrow septum ornamented with a single line of small miliary granules.

The state of preservation of our specimen unfortunately does not permit of any remarks being made on the character of the ornamentation of the test.

The peristome is entirely hidden by a mass of matrix which covers a large portion of the actinal surface, and leaves only a part of the posterior margin of the periproct exposed. The aboral margin of this aperture is well rounded, and is probably distant from the ambitus nearly the length of the periproct.

Remarks. This species is readily distinguishable from the other Sindian forms of *Amblypygi*; and its nearest ally is to be found in *A. altus*, nobis, from the white limestone of Kachh (Cutch). The present species differs chiefly in the following points, viz.:—the more elongate and oval test, which is less in height and also much less bombous dorsally throughout the posterior half; the more generally tumid character of the actinal surface, and the absence of the transverse depression or curvature of that area, which is more or less conspicuous in the longitudinal profile-view of the test in *A. altus*; the ambulacral petals are much narrower, and the interporiferous areas more contracted, and the periproct is smaller, narrower, and placed at a greater distance from the margin.

Dimensions.

	millim.
Length of the test	74
Breadth of the test	66
Height of the test	39
Greatest width of the poriferous zone	2·50
Width of the interporiferous area at this part . . .	4
Greatest width of the interporiferous area	5·5
Greatest width of an antero-lateral petal	9

The proportion of length to breadth = 1 : 0·89.
The proportion of length to height = 1 : 0·52.

Locality. In the Khirthar series of strata. Outer (eastern) ridge of the Kámbhú range, west of Batcháni on the Báran. Survey-number $\frac{0:312}{318}$.

the actinal area, the comparatively thin and angular margin, and the well and uniformly arched dorsal surface; it is further characterized by the curve of the posterior petals, the subrostrate form of the posterior extremity, and perhaps also by the smaller and scantier primary tuberculation. When compared with a specimen of *A. subrotundus* of precisely similar size, these differences are very striking; they also appear to be sufficient to distinguish the species from the other known members of the genus.

Dimensions of type specimen.

	millim.
Length of the test	60
Breadth of the test	55
Height of the test	20
Greatest width of the poriferous zone	2·25
Width of the interporiferous area at the above place	4
„ „ „ at the margin	5·5
Greatest width of the postero-lateral petal	8·75
„ „ anterior petals	8

The proportion of length to breadth = 1 : 0·916.
The proportion of length to height = 1 : 0·333.

Locality. Khirthar series of strata. Hilly ground south-east of Trak Hill. Survey-number $\frac{G\,302}{122}$.

We also refer to this species a second specimen found at Roïs Hill, near Damaj, south of Búla Khán (Khirthar series). Survey-number $\frac{G\,302}{119}$.

Illustrations of the Species in Plate XXVII.

Fig. 1. Abactinal view of the test: natural size.
2. Actinal view of the test: natural size.
3. Longitudinal profile of the test: natural size.

3. **Amblypygus tumidus**, *Duncan & Sladen.* Plate XXVII, Figs. 4–6.

There is a test of a fine species of *Amblypygus* from the Khirthar series, but which unfortunately is so much obscured with matrix and otherwise badly preserved that only a partial description can be given. The test is high, with marginal contour subovoid, the greatest breadth being a little behind the anterior ambulacra, and the curve of the outline being sharper and more contracted posteriorly than anteriorly. The height is greater than half the breadth, and proportional to the length as 0·52 : 1, and the margins are thick and tumid. The curvature of the anterior slope of the longitudinal profile is less bombous than the posterior; and the posterior part of the test, as a whole, is thicker (higher) than the anterior. The transvere profile of the test shows a uniform convex curve of fair elevation. The actinal surface has a bombous aspect, and appears to have a very slight central concavity. The ambital margin does not at all overhang, but is bevelled away and well rounded.

The apical disk is concealed by matrix, but is probably central, or only very slightly excentric in front.

The ambulacra are flush with the surface of the test and lanceolate in outline; and the two lines of inner pores are straight, and converge gradually from the ambitus to the apex. The greatest width is at about two thirds the distance from the apex to the margin, the broadest part of the poriferous zone being somewhat nearer the apex; from this point of greatest breadth the poriferous zone contracts gradually until the margin is reached, the petaloid portion extending almost to the ambitus. The poriferous zone at its broadest part is five eighths of the width of the interporiferous area. The interporiferous zone is widest at the margin, and is there a little more than twice the width of the broadest part of the poriferous zone. The conjugate pores of the petaloid portion of the ambulacra are united by a well-defined furrow, and adjoining pairs are separated by a rather narrow septum ornamented with a single line of small miliary granules.

The state of preservation of our specimen unfortunately does not permit of any remarks being made on the character of the ornamentation of the test.

The peristome is entirely hidden by a mass of matrix which covers a large portion of the actinal surface, and leaves only a part of the posterior margin of the periproct exposed. The aboral margin of this aperture is well rounded, and is probably distant from the ambitus nearly the length of the periproct.

Remarks. This species is readily distinguishable from the other Sindian forms of *Amblypygi*; and its nearest ally is to be found in *A. altus*, nobis, from the white limestone of Kachh (Cutch). The present species differs chiefly in the following points, viz.:—the more elongate and oval test, which is less in height and also much less bombous dorsally throughout the posterior half; the more generally tumid character of the actinal surface, and the absence of the transverse depression or curvature of that area, which is more or less conspicuous in the longitudinal profile-view of the test in *A. altus*; the ambulacral petals are much narrower, and the interporiferous areas more contracted, and the periproct is smaller, narrower, and placed at a greater distance from the margin.

Dimensions.

	millim.
Length of the test	74
Breadth of the test	66
Height of the test	39
Greatest width of the poriferous zone	2·50
Width of the interporiferous area at this part	4
Greatest width of the interporiferous area	5·5
Greatest width of an antero-lateral petal	9

The proportion of length to breadth = 1 : 0·89.
The proportion of length to height = 1 : 0·52.

Locality. In the Khirthar series of strata. Outer (eastern) ridge of the Kámbhú range, west of Batcháni on the Báran. Survey-number $\frac{G\ 302}{318}$.

Illustrations of the Species in Plate XXVII.

Fig. 4. Abactinal view of the test: natural size.
5. Actinal view of the test: natural size.
6. Longitudinal profile of the test: natural size.

4. AMBLYPYGUS LATUS, *Duncan & Sladen.* Plate XXVII, Figs. 7–9.

Test depressed, marginal contour subcircular, dilated transversely, the greatest diameter being situated a little behind the antero-lateral ambulacra. The rounding of the posterior portion of the marginal outline is somewhat flattened, and that of the anterior part more regularly circular. The height of the test is two fifths of the breadth, and proportional to the length as 0·41 : 1; and the dorsal surface is low but regularly convex, the margins being thick and tumid. The anterior slope of the longitudinal profile is more rapid than the posterior portion, and the test, as a whole, is rather more bombous along the lines of the posterior ambulacra than elsewhere. The transverse profile of the dorsal surface shows a regular convexity of wide curvature. The actinal surface is concave, the peristome being well sunken, and the surrounding portions of the test bombous, the convex curve merging without interruption with that of the inflated margin.

The apical disk is excentric in front, being distant from the posterior extremity $\frac{57}{100}$ of the entire length of the test. There are four generative pores, which are rather small, and the anterior are slightly nearer together than the posterior pair. One of the posterior pores is long and slit-like in the specimen under notice. The ocular plates are very small. The central madreporiform body is ornamented with a few small and rather widely-spaced granules.

The ambulacra are flush with the surface of the test and moderately wide; and the petaloid portion dies out before the actual margin is reached, where the dorsal surface commences the sharper curve of that part of the test. The ambulacra are equal, and the widest portion is situated somewhat nearer the apex than in the preceding species, and corresponds almost exactly with the widest part of the poriferous zone; at this place the width of the poriferous zone is exactly one half that of the interporiferous area. The interporiferous area attains its greatest width at the margin, where it is more than three times the width of the broadest portion of the poriferous zone. The outline of the petal is lanceolate; and the poriferous zones, after attaining their greatest width, taper off somewhat rapidly in breadth to the extremity of the petaloid portion of the zone. The conjugate pores are united by a well-defined groove, and the intervening septa are broad and ornamented by a single line of comparatively large granules. The extrapetalous portion of the zone consists of pairs of pores throughout, and is flush with the actinal surface of the test, no trace of any groove being present. The details of the structure of the ambulacra are similar to those described in the preceding species.

The ornamentation of the specimen has, unfortunately, been very badly preserved.

As far as can be made out, the primary tubercles of the abactinal surface appear to be somewhat more widely spaced than in the preceding species, and with wider granulated interspaces between the scrobicules; but only the faintest indication of their former presence remains here and there, and not a trace of the ornamentation of the actinal surface is preserved.

The peristome is subcentral or only very slightly excentric in front, and sunken in a well-defined depression of the actinal surface; it is large, irregularly subpentagonal, and oblique, the major axis being directed towards the right anterior interradium.

The periproct, although large, and its length slightly greater than the larger diameter of the peristome, is smaller proportionally than in any of the other species described. It is subpyriform, with the contracted extremity directed towards the peristome, the intervening distance being nearly equal to its own length. It is placed much nearer to the margin of the test.

Remarks. This species is, perhaps, nearly related to *A. dilatatus*, Agassiz, but appears to be well distinguished by the greater lateral expansion of the test, the more excentric position of the apical disk, and the more tumid margins. The poriferous zones are relatively broader, and the petals, as a whole, are perhaps narrower in the Sind specimen; the peristome also appears to be more deeply depressed, and the actinal surface more strikingly pulvinate. The periproct is smaller than in any other species of *Amblypygus*, whilst it is remarkably large in *A. dilatatus*; and there is no trace whatever of the furrows in which the poriferous zones of that species are sunken on the actinal surface.

Dimensions.

	millim.
Length of the test	53·5
Breadth of the test	55
Height of the test	22
From centre of apical system to anterior extremity .	23
„ „ posterior extremity .	30·5
Greatest width of the poriferous zone	1·75
Width of the interporiferous area at this place . .	3·50
„ „ at the margin . .	5·75
Greatest width of a petal	6·75

The proportion of length to breadth = 1 : 1·028.
„ „ to height = 1 : 0·411.

Locality. In the Khirthar series of strata: Rohri, Upper Sind. Survey-number $\frac{O\,280}{71}$.

Illustrations of the Species in Plate XXVII.

Fig. 7. Abactinal view of the test: natural size.
8. Actinal view of the test: natural size.
9. Longitudinal profile of the test: natural size.

Subfamily ECHINOLAMPINÆ.

Genus EOLAMPAS, *Duncan & Sladen*, 1882.

(See *antea*, p. 61, Part ii.)

1. Eolampas excentricus, *Duncan & Sladen*. Plate XXXI, Figs. 11–15.

Test of small or medium size. Marginal contour an oval escutcheon-shape, rounded in front, expanding gradually up to the point of greatest breadth, which is situated on a line with the outer extremities of the posterior petals, and from thence the outline contracts rapidly to form the rather prominent posterior rostration. The greatest breadth is about five sixths of the length, or as 0·83 : 1; the test, however, having a more elongate appearance than those figures would seem to indicate, consequent on the peculiarity of shape. The dorsal surface is subdepressed, generally convex, forming a subconoidal peak at the apical summit, and a more or less definite trace of carination along the median line of the posterior interradium. The actinal surface is almost flat, very faintly depressed in the region of the peristome, and merging outwardly into the rounding of the margin. The margin is well-rounded, moderately thick and tumid. Seen in longitudinal profile the extreme excentricity of the apical summit is remarkable, causing the anterior slope or curve to be rapid and precipitous, whilst the posterior slope is a gentle and gradual incline, until the posterior rostration is reached, over which it bends with a rapid well-rounded curve, terminating vertically. Seen in transverse profile the dorsal outline is markedly subconical.

The apical disk is small and very excentric in front, its distance from the anterior extremity being three tenths of the length of the test. There are four generative pores, the anterior pair being much closer together than the posterior pair; and five ocular pores, which are small and inconspicuous, excepting the odd anterior one, which appears to be larger and more deeply sunken than the rest.

There are only four ambulacral petals, the odd anterior ambulacrum being aborted. In the place of the pairs of pores of the odd anterior ambulacrum slight grooves are to be seen amongst the ornamentation, which are much more numerous than the pairs of pores in the other ambulacra; and occasionally in small specimens there is the indication of a very minute single pore here and there, but in large examples even these appear to be aborted. The paired petals are long and narrow, slightly converging towards the outer extremity, and the anterior pair are rather shorter than the posterior pair. The poriferous zones are equal, comparatively broad, and more than half the width of the interporiferous area. The pores are very small, round, wide apart, and are united by a well-defined conjugating furrow, the direction of which is oblique, in relation to the median line of the petal. The furrows are separated by rather broad costæ, ornamented with a single line of 5 or 6 small uniform-sized granules. The interporiferous areas are flush with the surface of the test, and their ornamentation is similar to that of the interambulacral areas of the test. The petals in their direction are nearly straight, the anterior pair being widely divergent and enclose a large angle, whilst that enclosed by the posterior pair is small.

The peristome is small, transversely oval, slightly angular laterally, and its position is excentric in front, but much less so than the apical disk. It has low vertical walls, which extend upwards into the interior, with the surface covered with rather large uniform granules. No development of bourrelets takes place, and there is no expansion of the ambulacra near the peristome, although in some specimens the semblance of a phyllode is produced by the deep and conspicuous puncture of the pores in this region, and more especially by the presence of large pits (probably for sphæridia) in the interporiferous area near the peristome.

The periproct is small, transversely oval and inframarginal, placed on the lower part of the marginal rounding, the plane of the orifice being consequently at an angle to the actinal surface, and visible when the test is viewed from behind.

The ornamentation consists of small primary tubercles in sunken scrobicules, uniformly and equidistantly distributed over the test, the interradial spaces being occupied by comparatively large distinct granules, which usually form a single circlet round each scrobicule, but occasionally a few intermediate granules are present between neighbouring circlets or at the angles.

Remarks. This Echinoid has an unmistakable facies, different from any other form. It is strikingly characterized by the peculiar shape of the test, the excentricity of the apical summit, and the abortion of the odd anterior ambulacrum. It differs from the species found in the Ranikot strata, *Eolampas anticursor*, nobis, by the more depressed test, by the peculiar escutcheon-shaped outline of the marginal contour, with the marked expansion behind the posterior petals, by the tendency to carination along the abactinal area, and the consequent subconoid profile when viewed transversely. The ambulacral petals are longer and their relative proportions *inter se* are different.

The form appears very constant, and is represented by a number of examples from several localities. In the smaller specimens, however, the dorsal carination and the depression of the test posteriorly, as well as the expansion laterally behind the line of the posterior petals, do not appear so marked.

Dimensions.

	a. millim.	*b.* millim.	*c.* millim.
Length of the test	18·5	14	9·5
Breadth of the test	15·5	11·25	8
Height of the test	9·5	8·5	5·5

Localities. In the Khirthar series of strata:—

i. Lowest scarp under Karothur hill, eight miles east-north-east of Júngsháhi (at the base of the group). Survey-number $\frac{G\,280}{118}$.

ii. Three or four miles south-south-east of Meting (at base of the scarp). Survey-number $\frac{G\,280}{111c}$.

iii. On the road about four miles west of Kotri. Survey-number $\frac{G\,236}{147}$.

Illustration of the Species in Plate XXXI.

Fig. 11. Abactinal view of the test: natural size.
12. Actinal view of the test: natural size.
13. Longitudinal profile of the test: natural size.
14. Abactinal area, showing the ambulacral petals and apical disk: magnified.
15. The peristome and surrounding portions of the test: magnified.

Genus ECHINOLAMPAS, *Gray*, 1825.

Test more or less oval in marginal contour, convex above, flat or subconcave beneath, margins more or less tumid.

Ambulacra petaloid, open at the extremity, and not greatly convergent. Poriferous zones with the inner pores round and the outer pores elongate, the pairs being united by a conjugating groove. Ambulacral summit usually excentric in front. Apical disk compact.

Peristome subcentral or slightly excentric in front, subpentagonal, transverse: floscelle present, often feebly developed.

Periproct oval, transverse, inframarginal, or on actinal surface close to the posterior margin of the test.

Ornamentation homogeneous. Tubercles small, perforate, non-crenulate, sunken in scrobicules, uniform and crowded; miliary granulation more or less compact.

1. Echinolampas rotunda, *Duncan & Sladen*. Plate XXVIII, Figs. 1–6.

Test of moderate size. Marginal contour subcircular, with a slight tendency to elongation in the longitudinal axis, and a slight protuberance, more or less pronounced, in the posterior part of the lateral interradia corresponding with the line of greatest breadth. The length is very little greater than the breadth, the proportion being as 1:0·94. The dorsal surface is flatly subconoid, the margins being very thick and regularly tumid. The apical summit of the test is excentric in front, and its height is rather more than half the length, being in the proportion of 0·58:1. Seen in longitudinal profile, the anterior slope of the test is more rapidly inclined than the posterior, and appears to pass continuously from the apex over the thick, high margin as a portion of a parabolic curve. The posterior slope is faintly depressed at a short distance from the apex, and is the fullest and most convex just above the posterior margin, over which it passes almost precipitously. The transverse profile shows the subconoid character of the dorsal surface, and the margins are thick and tumid. The actinal surface is remarkably pulvinate, the test being tumid around the deeply-depressed peristome, the tumidity being greatest along the median line of the posterior interradium, and extending around the lower margin of the periproct.

The apical disk, which corresponds with the summit of the test, is rather large. There are four generative pores, the anterior pair being closer together than the posterior pair; and the central disk, which is entirely occupied by the punctures of the madreporite, is large and flat. The ocular plates are small and subcrescentiform.

The ambulacral petals are long, extending nearly to the ambitus, distinctly petaloid in outline, expanding in the middle portion, and contracting slightly towards the outer extremity. The posterior pair are the longest and broadest, and the odd anterior ambulacrum is the shortest and narrowest. The greatest breadth of the postero-lateral petal is about $\frac{146}{1000}$ of the length of the test, being 8·50 millim. in a test 58 millim. long. The poriferous zones in the postero-lateral and in the odd anterior petals are subequal, the companion zones in each petal not varying in length from each other by more than one or two pairs of pores. In the antero-lateral petals, however, the posterior zone is longer than the anterior zone of the same petal by ten or more pairs of pores. The posterior zone of the antero-lateral petals is more curved than the companion zone, forming a rather wide sweep into the lateral interradia, the convexity directed backwards. The relative curvature of the zones in the other petals is about equal; and the general direction of the petals from the apex outwards is almost straight. The poriferous zones are comparatively narrow, varying very little throughout their length after attaining the normal width at a short distance from the apex, and their width decreasing very slightly at the outer extremity. The inner pores are round, the outer pyriform or comma-shaped, and they are united by a deep, well-defined groove. The divisional costæ are narrow, and were originally ornamented with a single row of five or six small granules, of which, however, nearly all traces are now obliterated, except in one or two very rare instances. The position of the pairs of pores and of the costæ is slightly oblique, the line of direction from the inner to the outer pore being slightly adoralwards. The width of the poriferous zone at its widest part is 1·50 millim.; and the width of the interporiferous area at the broadest part of the postero-lateral petal is 5·5 millim. The extra-petalous continuation of the poriferous zone is indiscernible until well on the actinal surface, where its course is indicated by a very shallow depression, which becomes more distinct as it approaches the peristome. The interporiferous area within the petals is slightly tumid, and its ornamentation is similar to that of the interradia, consisting of numerous small primary tubercles situated in rather deep scrobicules, so closely placed that the interspaces, which are always less in breadth than the diameter of a scrobicule, have usually only the two rows of miliary granules upon them which form the boundary of two adjacent scrobicules, one round each. The tubercles are the most numerous and crowded at the ambitus and just beneath, and the most widely spaced in the neighbourhood of the peristome. They are, perhaps, a shade larger on the actinal surface, but the difference is very slight.

The peristome is slightly excentric in front; it is large, subpentagonal, deeply impressed, and with high vertical walls. The ambulacral areas become very contracted as they approach the peristome, and are slightly sunken, forming shallow troughs, especially in the three anterior ambulacra, which emphasize the very slightly swollen, incipient bourrelets of the anterior interradia. This slight development of the bourrelet is wanting in the three posterior interradia; and the margin of the peristome bounded by the odd posterior interradium has the test rather less tumid, and is instead more inclined towards the mouth, than the other parts surrounding the aperture.

There is no development of a true phyllode, although a slight tendency exists to form an inner series of pores, caused by the stepping out of an occasional pore here and there from the normal uniserial rank. The transverse diameter of the peristome measures about 8 millim., and the longitudinal 5 millim.

The periproct is very large, subtriangular in outline; the outer margin, which forms the base of the triangle, being a gentle curve, the inner margin being bounded by two very slightly curved lines, which form the sides of the triangle, the apex directed towards the peristome, and the lateral angles being sharp. The periproct is entirely on the under surface, close to the margin, and, being situated on the slight outward slope of the ventral tumidity, its plane is directed slightly upwards. The shorter diameter of the aperture, which corresponds with the longitudinal axis of the test, measures 6·5 millim., and the transverse diameter 12 millim.

Remarks. This species is, perhaps, most nearly allied to *E. discoideus*, d'Archiac; but is distinguished from that form by its higher test, its subconoidal abactinal surface, and its higher and more tumid margins. It is further distinguished by the slightly tumid interporiferous areas and the distinctly petaloid outline of the ambulacra, the former in *E. discoideus* being flush with the test, and the latter almost as completely open as in *Conoclypeus*. In *E. discoideus* the actinal surface is described as "sub-plan," and the periproct small and fairly regularly elliptical. In these points this species is very different. We know of no other form with which *E. rotunda* can be confounded.

There is a crushed specimen which is larger and more elongate than the type, and in which the actinal surface appears to be somewhat less tumid; but this is, perhaps, owing to the damage it has sustained. In all points of detail it accords fully with the type we have described.

Dimensions.

	a. millim.	*b.* millim.	*c.* millim.
Length of the test	58	58·5	67
Breadth of the test	55	54·5 (broken)	60·5
Height of the test	34	34	27·5 (crushed)
Breadth of postero-lateral petal .	8·50	8·50	8·80
" of antero-lateral petal .	7·40	7·40	8

Locality. In the Khirthar series: River-section, east of Trak. Survey-number $\frac{G\ 226}{103}$.

Illustrations of the Species in Plate XXVIII.

Fig. 1. Abactinal view of the test: natural size.
2. Actinal view of the test: natural size.
3. Longitudinal profile of the test: natural size.
4. The apical disk: magnified.
5. A portion of a petal, about midway between the extremity and the apex: magnified.
6. The peristome and surrounding portions of the test: magnified.

2. **Echinolampas subconica**, *Duncan & Sladen.* Plate XXVIII, Figs. 7–11.

Test of moderate size. Marginal contour suboval, slightly expanded in the posterior region of the lateral interradia, evenly rounded in front, feebly rostrate behind. The length is rather greater than the breadth, being in the proportion of 1 : 0·86. The dorsal surface is moderately high, subconical, and rather pointed at the apex, which is excentric in front, and the greatest height is rather less than three fifths of the length. Seen in longitudinal profile, the anterior and posterior slopes of the abactinal surface appear as two gentle, evenly-rounded, convex curves of low curvature, culminating rather sharply or pointedly at the apex; the anterior slope is much shorter and more precipitous than the posterior, and continues, without any interference, in its course over the thick and well-rounded anterior margin; the posterior slope is less inclined than the anterior, and extends as a regular convex or subparabolic curve from the apex to the margin of the periproct, just below the ambitus, the posterior margin of the test being much thinner and less tumid than the anterior. Seen in transverse profile, the abactinal surface slopes rather rapidly from the apex, and the curvature being slight, the conical appearance is greatly emphasized, the outline passing without interruption over the moderately thick and well-rounded margins. The actinal surface is pulvinate, the peristome being depressed and the surrounding test being tumid, sloping inwards to the mouth, and outwards with a slow and gradual curve to the ambitus. The anterior and the posterior portions of the test are the most tumid; and the test, when placed on a level surface, rests on these regions of the test entirely. The lateral interradia are slightly more tumid along their median line, which gives, though faintly, a rather undulating appearance to the actinal area.

The apical disk is excentric in front. In the specimen under notice there are only two generative pores, the left anterior and the left posterior pores being aborted; the whole of the centre of the disk is occupied by a rather large madreporiform body, which is not prominent, but is ornamented with a few moderately large granules widely spaced and irregularly placed.

The ambulacral petals are long and narrow. The posterior pair are the longest and the broadest; the anterior pair and the odd anterior ambulacrum are subequal in length, but the odd anterior petal is narrower than the pair. The shape of the petals is lanceolate and very attenuate and tapering to the apex, and their contraction at the outer extremity is very slight. The greatest breadth of the postero-lateral petal is 7 millim., or $\frac{107}{1000}$ of the length of the test. The poriferous zones in all the petals are slightly unequal; the posterior zone in the posterior petals and the anterior zone in anterior petals being shorter than the companion zones in the respective petals, the difference, however, not being more than five or six pairs of pores in the anterior petals, and less in the posterior petals. In the anterior pair of petals the posterior zone is more curved than the anterior zone; it is boldly convex into the lateral interradia, and presents a faint trace of sigmoid curvature in consequence of the zone at the extreme tip being slightly bent backwards. The posterior zone of the posterior petals is also slightly more curved than the companion anterior zone, and there is also the same faint outward turn of the poriferous zone at the extremity; but neither character is developed to the same degree as in the anterior petals. At the widest part of the posterior ambulacra, where the petal measures 7 millim. across, the interporiferous area is 4 millim. in breadth, and the poriferous zone is 1·50 millim. broad: from this point the zone diminishes in breadth to the outer extremity, where it is little more than half the width named, and less than 1 millim. across. At the outer extremity of the petal the interporiferous area measures 4·25 millim. across. The inner pores are round, the outer transversely oval, and they are united by a broad conjugating groove. The costæ are low and narrow, with a well-defined single row of about seven small miliary granules; and the positions of the costæ and the pairs of pores are oblique in relation to the median line of the ambulacrum. The extra-petalous continuations of the poriferous zones are scarcely perceptible until near the peristome, and are not placed in any channel on the actinal surface.

The interporiferous area within the petal is almost flush with the test, being very faintly tumid; and its ornamentation, which is similar to that of the interradia, is rather more ornate than usual in this genus. It consists of small primary tubercles placed in rather large and shallow scrobicules, which are surrounded by a single circlet of rather large, well-spaced, and comparatively isolated miliary granules. From these not forming the ordinary confluent ornamentation usual in the interspaces between the scrobicules in this genus, and from the small size of the primary tubercles, the general ornamentation is well characterized in the present species. At the ambitus and on the actinal surface the scrobicules are very closely placed, with not more than a single row of miliaries between each; but in places on the abactinal surface they are rather more widely spaced.

The peristome is slightly excentric in front; it is, unfortunately, too much obscured by matrix for any remarks to be made on its structure.

The periproct, which is of moderate size and transversely oval, is placed close to the posterior margin of the test, its aboral margin encroaching slightly thereon. The major diameter measures 10 millim., the minor diameter being probably little more than 5.

Remarks. This species has some resemblance to *E. rotunda*, but is readily distinguished by the different form and proportions of the test, by the narrow and apically-pointed and attenuate ambulacra, which are unequal and do not converge at their outer extremity, as well as by the different character of the ornamentation.

From *E. scutiformis*, Desm., it differs in the form of the test, the absence of the posterior rostration, the greater excentricity of the apical disk, and in the character of the ambulacra. It is likewise easily separated from *E. Studeri*, Agassiz, *E. Escheri*, Agassiz, and *E. globulus*, Laube, by the form of the test and the shape of the ambulacra, as well as by other points. We are unacquainted with any other Echinolampad with which it can be confounded.

Dimensions.

	millim.
Length of the test	65
Breadth of the test	56
Height of the test	33
Breadth of the postero-lateral petal	7
" " antero-lateral petal	6

Locality. In the Khirthar series: Twenty-four miles west of Kotri (entering the hills on the road to Búla Khán's Thána). Survey-number $\frac{G\,280}{72}$.

Illustrations of the Species in Plate XXVIII.

Fig. 7. Abactinal view of the test: natural size.
8. Actinal view of the test: natural size.
9. Longitudinal profile of the test: natural size.
10. The apical disk: magnified.
11. A portion of the petal about midway between the apex and the extremity: magnified.

3. Echinolampas obesa, *Duncan & Sladen.* Plate XXVIII, Figs. 12–16.

Test rather large. Marginal contour regularly oval, the breadth being about four fifths of the length or in the proportion of 0·8 : 1. The outline at the ambitus is well rounded in front and almost equally so behind, there being only the faintest trace of flattening in the curve behind the extremities of the posterior petals. The apical summit of the test is subcentral, and its height is about three fifths of the length of the test, or as 0·59 : 1. Seen in longitudinal profile the dorsal surface is full and convex, the posterior curve being fuller and more convex than the anterior; the posterior curve is uninterrupted by any marginal tumidity until it reaches the periproct; whilst the anterior curve passes gently over the thick and tumid anterior margin. Seen in transverse profile the dorsal convexity has a slightly conical appearance, merging imperceptibly into the marginal part of the test, and then curving rather sharply over on to the actinal surface. When seen from behind the periproct is wholly visible, being situated within the margin. The actinal surface is very tumid and pulvinate, the rounded summit of the tumidity midway between the ambitus and the peristome being the only resting plane of the test.

The apical disk is rather large and is placed considerably in front of the summit of the test, its distance from the anterior margin being about two fifths of the length of the test. The four genital pores are large and oval, and the anterior pair are nearer together than the posterior pair. The central portion is large, rather prominent, undulating, subtuberculate, with a few small widely-spaced granules, and the whole surface covered with the perforations of the madreporite. The ocular plates are very small, subtriangular in shape, and their foramina microscopic.

The ambulacral petals are long and comparatively narrow; the posterior pair are the longest and rather broader than the others, and the odd anterior ambulacrum is the shortest and narrowest. The posterior petals are slightly curved, with the convexity towards the posterior interradium. The poriferous zones diverge gradually in all the petals as they proceed from the apex, and their convergence towards the outer extremity is scarcely perceptible, not exceeding half a millim., their outline being in consequence wedge-shaped rather than petaloid. The greatest breadth of the postero-lateral petal is 8 millim., or about $\frac{112}{1000}$ of the length of the test. In the antero-lateral ambulacra the poriferous zones are unequal, the posterior zone being longer by about nine pairs of pores than its companion, and it is also more curved; but this only to a slight degree. The poriferous zones of the other petals are subequal.

The poriferous zones are rather narrow, measuring 1·5 millim. at the widest part and diminishing gradually towards the outer extremity, where they are little more than half this breadth. Near the apex the pores are unusually small, and, in the specimen under description, a number of the pairs of pores are aborted near the apex. The inner pores are round, the outer transversely elongate, and they are united by a broad groove. The intervening costæ are low, narrow, and are ornamented with a single line of about six well-defined granules. The positions of the pairs of pores and of the costæ are rather oblique in relation to the median line of the petal, and the obliquity increases as they approach the outer extremity. The extra-petalous continuations of the poriferous zones are situated in very slight channels. The width of the interporiferous area at the widest part of the postero-lateral petal is 4 millim., and it is only a shade narrower than this at the outer extremity; towards the apex the areas are narrow and attenuate, and resemble *E. subconica*, nobis, in not expanding rapidly into the petaloid form so frequent in this genus. The interporiferous areas are flush with the test, or only so faintly tumid that the character is scarcely noticeable. The odd posterior interradium is very full and tumidly convex, with a tendency to become subcarinate at the apical extremity; there is also a slight tendency, but much more feebly exhibited, in the other interradia (especially the laterals) to become a little prominent near the apex, which produces the appearance of the ambulacra being slightly sunken there. The lateral and anterior interradia do not present any conspicuous tumidity, and the test, as a whole, is gradually reduced in capacity towards the anterior extremity. The ornamentation of the interporiferous areas is similar in character to that of the interradia, excepting that the primary tubercles are somewhat more regular in position and more closely crowded. Throughout the test the scrobicules are closely placed, the intermediate spaces being seldom occupied by more than the single circlet of comparatively large, well-spaced miliary granules, which surround the scrobicules. The ornamentation is most crowded just below the ambitus, the intermediate spaces between the scrobicules being reduced to simple septum-like structures. The ornamentation of this species seems to stand intermediate between that of *E. subconica* and that of the ordinary *Echinolampas* type.

The whole of the central portion of the actinal surface is obscured by matrix, which renders any observations on the peristome and neighbouring portions of the test impossible.

The periproct is situated in the actinal portion of the tumid curve of the margin, and is consequently truly marginal. Its shape is transversely oval, and the greater and less diameters are not more than 9 and 7 millim. respectively; but, owing to fracture, the exact measures cannot be given.

The test subjacent to the adoral margin of the periproct shows traces of some tumidity, and there is a slight bevelling of the test towards the aperture on that margin.

Remarks. This form has some affinities with *E. subconica*, nobis, and also with that group of Echinolampads of which *E. Escheri*, Agassiz, and *E. subcylindricus*, Desor, are the representatives. It is distinguished from *E. subconica* by the form of the test, the position of the apical summit, and the trend of the posterior petals, as well as by the position of the periproct and the general tumidity of the lateral regions of the test and of the actinal surface. It is readily distinguished from both *E. Escheri* and *E. subcylindricus* by the form of the test and by the character, outline, and position of the ambulacral petals. It is probably, however, the eastern representative of the last-named species, although the differences between them are very great.

Dimensions.

	millim.
Length of the test	71
Breadth of the test	57
Height of the test	42
Breadth of the postero-lateral petal . . .	8
„ „ antero-lateral petal . . .	7

Locality. In the Khirthar series of strata. Twenty-four miles west of Kotri (entering the hills on the road to Búla Khán's Thána). Survey-number $\frac{O\ 280}{72}$.

Illustrations of the Species in Plate XXVIII.

Fig. 12. Abactinal view of the test: natural size.
13. Actinal view of the test: natural size.
14. Longitudinal profile of the test: natural size.
15. The apical disk: magnified.
16. A portion of a petal about midway between the apex and the extremity: magnified.

4. ECHINOLAMPAS SINDENSIS, *d'Archiac.* Plate XXIX, Figs. 1–10.

Test usually of moderate size, but occasionally attaining large proportions. Marginal contour oval, well rounded in front, sometimes rather flattened along the sides, and faintly rostrated posteriorly. The breadth is in the proportion of 86 per cent. of the length. Apical disk excentric in front and corresponding with the apical summit of the test, its distance from the anterior extremity being 40·6 per cent., or a little more than two fifths of the length of the test. The dorsal surface is moderately high and well arched, measuring at the summit a little more than 45 per cent., or nine twentieths of the length of the test. Seen in longitudinal profile the dorsal outline shows a well-rounded convexity, the anterior slope being more precipitous than the posterior, the posterior slope rounding gently and then curving rapidly over the posterior rostration. The transverse profile shows a regular and almost semicircular curve. The margins are tumid and rather sharply rounded on to the actinal surface, which is more or less plain, excepting a gentle depression around the peristome, and the rounding which masks the imperceptible junction of the margins and the actinal surface.

The apical disk is small; and there are four genital pores, which are large and oval, occupying nearly the whole of their plate; the anterior pair rather closer together than the posterior pair. The ocular plates are small and their pores very minute, and the posterior pair are wide apart. The whole of the central portion is occupied by the madreporiform body, and this, in some instances, is slightly convex.

The ambulacral petals are narrow, and of almost uniform breadth a little distance from the apical disk, expanding very slightly near the middle of their length, and the contraction at the outer extremity being also very insignificant. They terminate somewhat abruptly at a short distance before the rounding of the margin commences. The posterior petals are the longest, and the odd anterior petal is slightly narrower than the others. The breadth of one of the paired petals is in the proportion of about $\frac{103}{1000}$ of the length of the test. The poriferous zones are unequal; the anterior zones of the antero-lateral petals and the posterior zones of the postero-lateral petals being shorter than the companion zone of the same petal. The breadth of the poriferous zone, excepting the narrow apical extremity, varies only slightly throughout the remaining portion of its length, the increase in size at the widest part, and likewise the decrease towards the outward extremity, being slight. At the widest portion of the petal the width of the poriferous zone barely exceeds one fourth of the width of the interporiferous area, the actual breadth of the zone being only a shade more than 1 millim. in an example 58 millim. in length. The inner pores of a zone are round, and the outer pores elongate or pyriform, the pair being united by a well-defined channel. The divisional septum between each pair is rather broader than the conjunctive channel, and is ornamented by a single line of small miliary granules. At about one fourth of the distance from the apical to the outer extremity of the postero-lateral petals the anterior zone is bent slightly outward, appearing to curve somewhat encroachingly upon the postero-lateral interradial area, whilst the posterior zones are comparatively straight and do not correspondingly encroach upon the odd posterior interradium. This gives the character of a slightly outward flexure to the posterior petals. At the extremity of the petals, where the conjugate pores cease, the poriferous zone is continued in a single line of pores, sunken in a faint depression or channel, and extending up to the peristome, in the neighbourhood of which there is some irregularity in the serial arrangement of the pores consequent on the presence of intercalated ambulacral plates, by which the incipient phyllode is produced. The lines formed by the simple portion of the two poriferous zones of a petal expand wider apart as they proceed from the extremity of the petal to the ambitus, and again converge from the ambitus to the peristome. The course of the three anterior ambulacra on the actinal surface is comparatively straight, that of the posterior pair being more or less curved, bending with a slight and graceful flexure which encroaches on the odd portions of the interradial area. The interporiferous areas are flush with the surface of the test, both within and without the petal, and their ornamentation is similar to that of the interradial areas.

The antero-lateral and the postero-lateral interradial areas present no tumidity either in the abactinal or actinal regions. The odd posterior interradium is slightly tumid dorsally over, and in conformity with, the posterior rostration; and there is also a swelling along the median line of this area on the actinal surface, which expands towards the margin in the neighbourhood of the periproct. The ornamentation of the interradial and interporiferous areas is uniform and small; it consists of numerous small primary tubercles, indistinctly crenulated, and with a minute perforated mamelon, sunken in deep narrow scrobicules, the intermediate spaces being very narrow, in the narrowest part not more than the width of a single row of granules, and at the wider parts, in the spaces between adjacent scrobicules, always less than the width of the scrobicule. The surface is covered with very minute and not particularly closely crowded miliary granules. The primary tubercles are the most crowded at the ambitus, and become slightly larger and rather more widely spaced on the actinal surface. A well-defined band, devoid of primary tubercles, extends along the median interradial line between the peristome and the periproct.

The peristome is large, central, sunken in a slight depression of the test, pentagonal, having the transverse diameter greater than the longitudinal. The ambulacral areas, as before noticed, contract on approaching the peristome, and at a short distance from the extremity are sunken in a depression which increases until it falls into the peristome, where the test is well channelled-out; in this manner a prominence is given to the otherwise feebly-developed bourrelets. The two anterior bourrelets are broader and more pronounced than the postero-laterals, and the odd posterior one is also broader and somewhat flattened along its margin. The floscelle is only feebly developed, the rudimentary phyllodes being very inconspicuous and represented only by a short line of four or five supplementary pores within each column of ambulacral plates. The pores are rather wide apart; and the two lines of supplementary pores, present in each ambulacrum, converge slightly as they approach the peristome. Sometimes there is a faint outswelling of the poriferous zone just before the extremity, and not unfrequently some irregularity in the serial disposition of the pores, which slightly emphasizes the character of the phyllode.

The periproct is large, transverse, subelliptical, placed close to the margin, on the rounding which unites the ambitus with the actinal surface and immediately under the posterior rostration. Consequent on this slightly oblique position (in relation to the plane of the actinal surface), the presence of the orifice is just discernible when the posterior part of the test is placed in direct line of view. This aperture has a major diameter of 10 millim. and a minor diameter of 5 millim., in an example 66 millim long; the major diameter of the peristome being about 7 millim., and the minor little more than 4 millim., in the same specimen.

Premature form. In young examples, which measure 43 millim. in length, the test is relatively higher, much thicker and more tumid at the margins, and tumid on the actinal surface, the flatter character of the adult form being as yet undeveloped. The peristome is large and subelliptical, without any trace of the pentagonal outline; and the bourrelets are indicated only by the faintest swelling of the plates in the two anterior interradial areas. The periproct is large, and is situated at a higher level than in the adult, and is quite in the margin. Examples having broad poriferous zones are clearly distinguishable at this age from those with the narrow zones—size and all other characters of the tests being similar. We are unfortunately not in a position to say any thing as to the form of the earlier stages of this species; but it may be mentioned parenthetically that some small tests, which we have regarded as the young of another species (*Echinolampas angustifolia*), may possibly belong to *E. Sindensis*. The grounds upon which our determination is based will be found in the description of the species in question; and we at present confine ourselves to mentioning the circumstance in the hope that a larger supply of material will furnish a solution to the difficulty.

Remarks. The type of d'Archiac's species in the Museum of the Geological Society is a very unsatisfactory specimen and scarcely worthy of recognition; it also accords very poorly with the description given in the text (*op. cit.* p. 210), and likewise with the figures. Under these circumstances it would obviously be both useless and unprofitable to draw any lengthy comparisons. Numerous specimens of an *Echinolampas* which appears to be very common in Sind, and accords most nearly with the old specimen above referred to, and which has further been regarded provisionally by the Surveyors (although with doubt) as probably belonging to d'Archiac's species, are well represented in the collection of Khirthar fossils. It is to this form that we have assigned d'Archiac's specific name, rather from unwillingness to burden the nomenclature with an additional name than as an expression of our opinion as to its conformity with the unintelligible and contradictory type and description of our predecessors. The form is well marked, and we are unacquainted with any other species with which it can be confounded. The variety *hemisphærica* is also well marked, and has not yet been found associated with the type-form of the species.

Dimensions.

	a. millim.	*b.* millim.	*c.* millim.	*d.* millim.
Length of the test	90	59	57	52
Breadth of the test	75	50	48	35
Height of the test	45	27	23	22
Breadth of postero-lateral petal .	9·5	6	6	4·25

Locality. In the Khirthar series of strata: Baili, west of Tóng. Survey-number $\frac{G\,304}{23}$.

Illustrations of the Species in Plate XXIX.

Fig. 1. Abactinal view of the test of a large example: natural size.
2. Longitudinal profile of the same specimen: natural size.
3. Abactinal view of a test of the ordinary size: natural size.
4. Actinal view of the same: natural size.
5. Longitudinal profile of the same: natural size.
6. Peristome and surrounding parts of the test from another specimen: magnified.
7. A portion of the ambulacral area, near the middle of a petal: magnified.
8. Abactinal view of the test of a young specimen: natural size.
9. Actinal view of the same test: natural size.
10. Longitudinal profile of the same· natural size.

5. Echinolampas Sindensis, var. hemisphærica, *Duncan & Sladen*. Plate XXIX, Figs. 11–17.

On examining a large series of specimens from different localities a considerable amount of variation may be observed. This chiefly affects the proportions of length, breadth, and height; and, although associated in some instances with other small structural modifications, which separately and at first sight appear striking, we do not, after a careful comparative review of the series, feel justified in regarding them as specifically distinct from the present form.

A well-marked variety, constant through various phases of growth and in different localities, is characterized in the following manner. The disproportion between the length and breadth is rather less, and the marginal contour is also more truly oval; the height is greater, the dorsal surface has a more inflated appearance, and when seen in longitudinal profile is almost semicircular, the difference between the curvature of the anterior and posterior slopes being scarcely perceptible. The rounding at the margin is somewhat sharper, which gives the actinal surface a rather flatter appearance; and this character is further emphasized by the slightly smaller extent of the central depression of the test around the peristome. The bourrelets are, perhaps, rather more prominently developed. The summit of the test is more central, and consequently behind the apical disk. The poriferous zones are broader in relation to the interporiferous area.

Although the majority of the characters here noticed are found in specimens which we regard as the young of the type form of *E. Sindensis*, they are remarkably constant in a series of tests of all sizes, the greater number being quite as large as those of *E. Sindensis*, which present all the characters ascribed to the adult form of the type, and one example being much larger than the average size of that form. If only a small number of examples had been available for study, it is probable that the form would have been regarded as a separate species; but after studying the material at our disposal we do not at present feel justified in considering this form otherwise than as a well-marked variety of *E. Sindensis*. In addition to the remarks above made as to the young stages of growth, it may also be observed that examples of the type form occur in which the test is higher than usual, with the dorsal profile approaching the hemispherical outline, and which have the wide poriferous zones characteristic of our variety.

Young forms. The characters above enumerated are present in a relative degree throughout a series of specimens which range from 40 to 77 millim. in length. A smaller test, 32 millim. in length, which, from its general habit and association, we also place under the variety, approaches a subcylindrical form. The margins are thick and tumid; the actinal surface tumid, and with no trace of the flatness which characterizes the later stages of growth. Unfortunately the details of this example are badly preserved. A drawing of the specimen is given in Figs. 16 & 17.

Dimensions.

	a. millim.	b. millim.	c. millim.	d. millim.
Length of the test	78	55	50	31·5
Breadth of the test	69	48	44	26
Height of the test	37	30	27	20
Breadth of postero-lateral petal . .	10·5	7	7	4

Localities. In the Khirthar series:—

i. Rohri, Upper Sind. Survey-number $\frac{G\,280}{71}$.

ii. Rohri on the Indus, Upper Sind. Survey-number $\frac{G\,226}{128}$.

iii. West side of Bhago-Thoro hill, south of Sehwan. Survey-number $\frac{G\,228}{96}$.

Illustrations of the Variety in Plate XXIX.

Fig. 11. Abactinal view of the test: natural size.
12. Actinal view of the same: natural size.
13. Longitudinal profile of the same: natural size.
14. Longitudinal profile of another specimen, somewhat less tumid: natural size.
15. Longitudinal profile of a large specimen: natural size.
16. Abactinal view of the test of a small specimen: natural size.
17. Longitudinal profile of the same: natural size.

6. ECHINOLAMPAS ANGUSTIFOLIA, *Duncan & Sladen.* Plate XXX, Figs. 1–11.

Test of moderate size. Marginal contour elongately oval, presenting no prominences to disturb the regularity of the outline, excepting the more or less prominent posterior rostration. The breadth is equal to about four fifths of the length, or is in the proportion of 0·79 : 1. The dorsal surface is high and tumid; the height about equal to half the length. The apical disk is excentric in front, the relation of the anterior to the posterior portion of the median line being approximately in the proportion of 2 : 3. Seen in longitudinal profile, the posterior slope of the dorsal outline has a very small angle of inclination, and then curves rapidly at the posterior extremity, which is very high and thick. Unfortunately in the type specimen this extremity has been destroyed, and also the anterior part of the dorsal surface. In two smaller examples the anterior slope is much more inclined, and the anterior margin comparatively thin. That this was also the character of the larger specimen there is little doubt, from the indications that remain. In the smaller specimen, two thirds the size of the type, the periproct is placed very high in the margin, wholly removed from the ventral surface, and almost vertical in position; it is slightly arched over by the posterior rostration. The transverse profile shows the dorsal area to be a regular convex curve of low elevation, with the sides of the test very thick and tumid, and the outline curving thence gently on to the tumid actinal surface. The tumidity of the actinal surface is very characteristic; the test around the peristome is moderately depressed, and there is a strongly marked tumidity, amounting almost to carination, along the median line of the posterior interradium, increasing towards the margin, and forming a prominent swelling of the test beneath the level of the periproctal aperture.

The ambulacral petals are narrow. The posterior pair are long, straight, and lanceolate in form, expanding slightly towards the middle portion, and then contracting towards their outer extremity. The poriferous zones are narrow, and vary only slightly throughout their length; the increase in breadth towards the widest part being slight, and the contraction towards the extremity comparatively small. In the posterior pair of petals the anterior zone is three or four pairs of pores longer than the posterior zone. The breadth of one of the posterior petals is in the proportion of about $\frac{100}{1000}$ of the length of the test; and the breadth of the poriferous zone at its widest part is one fourth of the width of the interporiferous area. The anterior petals are much shorter than the posterior petals, the posterior zone is longer and more curved than the anterior zone, the antero-lateral petals are rather narrower than the postero-laterals, and the odd anterior petal is still narrower than the anterior pair. The interporiferous areas are raised and tumid, which gives a very marked feature to the species. The continuation of the poriferous zones beyond the petal is almost indiscernible, there being no channel or depression to mark the course of the line of small, single, and rather widely spaced pores.

The ornamentation of the interporiferous areas is similar to that of the interradial portions of the test. It consists of small, closely crowded primary tubercles, sunken in narrow scrobicules, the intermediate portions being prominent, confluent, narrow, and in all cases narrower than the width of the scrobicules. The ornamentation of the actinal surface is somewhat larger than that of the abactinal, and maintains the same general character.

Unfortunately all our specimens are badly preserved in respect to their minute structure, which has been more or less obliterated by weather action. The interradial areas on the abactinal surface are very even, and present no tumidity or irregularities; and the same may also be said of their aspect on the actinal surface, excepting the odd posterior interradium above noticed.

The peristome is subcentral, and sunken in a slight depression of the actinal surface; around this depressed portion the test is tumid, and thence passes in a continuous and uninterrupted curve round the tumid margins and on to the abactinal surface. In the large specimen the mouth-aperture and the neighbouring portions of the test are concealed; but in one of the smaller examples the peristome, which is distinctly excentric in front, is conspicuously pentagonal, the sides very nearly equal, and having the transverse diameter or breadth only a little greater than the longitudinal diameter or length. The angles of the pentagon are rounded, and the surface of the two anterior interradial spaces is faintly swollen, suggestive of incipient bourrelets. The phyllodes are comparatively well developed, and four or five plates having supplementary pores are present in a column. In this specimen there is a broad smooth band devoid of primary tubercles extending between the peristome and the periproct. A similar band appears to have existed in the larger or type example, but owing to its state of preservation it is impossible to say definitely.

The periproct is transverse and subelliptical, equal in breadth to the transverse diameter of the peristome (5·5 millim. in a specimen 39 millim. long); it is marginal in position, and wholly visible when the posterior extremity of the test is placed in the direct line of view. The character of this aspect of the test may be seen in Figs. 5 & 9. It is probable that the great height of the periproct in the small specimen is in a certain measure a premature character; but we are unable to say to what extent it was maintained in the larger and more perfectly developed form.

Young Forms. There are two small tests, one measuring 24 millim. in length and the other slightly larger, which we regard as the young of this species. The prominent characters which have led to this determination are the lanceolate form of the petals, the tumid and raised interporiferous area, the tumid actinal surface, the distinctly pentagonal peristome, the great height of the posterior portion of the test, and the intra-marginal position of the periproct.

The longitudinal profile of the dorsal surface of this small test corresponds exactly with that of the adult form. The marginal contour is regularly oval, but is rather less elongate than in the type. The actinal surface, though tumid, is scarcely as much so as in the larger specimen; and the same remark applies to the example 39 millim. in length previously noticed. The ambulacral petals on the dorsal surface are distinctly lanceolate in outline, contracting sensibly towards their outer extremity; and the interporiferous area is tumid. The poriferous zones are very unequal, the posterior zones of the posterior petals being scarcely two thirds the length of the companion zone; and the anterior zones of the anterior petals are much shorter than their companions, but the disparity is not as great as in the posterior petals. The peristome is large and distinctly pentagonal, the two anterior bourrelets are faintly developed, and the character of a phyllode is already discernible from the size and disposition of the ambulacral plates and pores, which occupy the region of its position, although the secondary pores do not yet appear to be present. The periproct is large, entirely removed from the actinal surface, and is placed very high in the posterior margin; when the profile of the test is seen from behind, the aperture appearing to occupy a position nearly midway between the dorsal and ventral surface-lines. The posterior odd interradium is faintly rostrate and faintly keeled along the median dorsal line; ventrally this area is more tumid than the others, but not in so great a degree as in the more fully developed tests.

In the ornamentation of the test a number of the primary tubercles on the actinal surface occupy an excentric position within their scrobicule, being close to the anterior margin of the same.

Remarks. From the circumstance that this species has as yet only been found in association with *Echinolampas Sindensis*, and from our ignorance of the characters of the young tests of that species of corresponding size to the examples under notice, we felt some hesitation in determining these small specimens. The characters above mentioned appear sufficient, however, to justify the decision we have arrived at; and that opinion is further strengthened by the fact that in much larger examples of *E. Sindensis*, and of its variety, the peristome is still elliptical, without any trace of pentangularity, the ambulacra are straight and not lanceolate, the interporiferous areas are flush with the surface of the test and not tumid, and the periproct is distinctly infra-marginal. These characters, in association with the embryonic form of the peristome, would seem to almost preclude the possibility of the small tests under notice being placed as the young of *E. Sindensis*.

Dimensions.

	Length in millim.	Breadth		Height	
		in millim.	Proportion to length = 1.	in millim.	Proportion to length = 1.
(*a*)	60	47·5	0·79	30	0·50
(*b*)	47	35	0·74	21 (crushed)	
(*c*)	39	30·5	0·78	19	0·487
(*d*)	24	20	0·83	13	0·54

	millim.
Greatest width of the postero-lateral petal in (*a*) the type specimen . .	6
Width of the interporiferous area at this place	4
Greatest width of the poriferous zone	1

Localities. In the Khirthar series :—i. Baili, west of Tóng. Survey-number $\frac{G\,304}{23}$.

ii. South-west of Jhirak. Survey-number $\frac{G\,226}{165}$. (A very badly preserved specimen, almost indeterminable.)

Illustrations of the Species in Plate XXX.

Fig. 1. Abactinal view of the test: natural size.
2. Actinal view of the test: natural size.
3. Longitudinal profile of the test: natural size.
4. Actinal view of another specimen: natural size.
5. Transverse profile of the same specimen seen from behind: natural size.
6. Abactinal view of the test of a young specimen: natural size.
7. Actinal view of the same: natural size.
8. Longitudinal profile of the same: natural size.
9. Transverse profile of the same seen from behind: natural size.
10. Peristome of the same specimen: magnified.
11. Primary tubercles on the actinal surface of the same specimen: magnified.

7. ECHINOLAMPAS NUMMULITICA, *Duncan & Sladen*. Plate XXX, Figs. 12–15.

Test of large size; marginal contour suboval, slightly prominent in the posterior portion of the lateral interradia where the greatest breadth occurs, and with a well-developed posterior rostration. The greatest breadth is proportional to the length as 0·77 : 1. The dorsal surface is regularly convex, and the height is about two fifths of the length, or as 0·4 : 1.

The apical disk corresponds with the summit of the test, and is excentric in front, the relative proportions of the anterior and posterior portions of the median longitudinal line being as 2 : 3 approximately. Seen in longitudinal profile, the anterior slope of the dorsal outline is more rapid than the posterior, the degree of curvature is small, and the anterior margin is thick, tumid, and well rounded; hence it follows that, when viewed from above, the anterior part of the test has a comparatively even, rather than a tumid, character. The posterior slope of the longitudinal profile of the dorsal surface is a gentle curve, increasing as it reaches the posterior extremity, the character of the posterior rostration being scarcely perceptible in this aspect. The transverse profile presents a regular convex curve on the dorsal portion, which passes gently over the well-rounded margins. The actinal surface has a subconcave appearance; the peristome is sunken in a general depression of the test, and the surrounding portions are slightly tumid, and pass uninterruptedly and without any rapid change of curve or angularity into the tumid margins of the test.

The ambulacral petals are long, narrow, and gracefully flexuous, expanding slightly as they proceed outward, the widest part of the interporiferous area being at the extremity. The posterior petals are the longest, and are rather broader than the others, the odd anterior petal being the narrowest. The greatest width of one of the posterior petals is very near to the extremity, and is about equal to one tenth of the length of the test. The disparity in the length of the poriferous zones is small. The posterior petals at a short distance from the apex bend slightly outward, encroaching on the lateral interradia, the curvature then turns slightly inwards on to the posterior interradium, and is again directed outwards before passing on to the rounding of the margin; in this manner a graceful flexure is produced. The anterior pair of petals curve considerably on to the postero-lateral interradia, then over on the antero-lateral interradia, and finally bend again rather sharply backwards near the extreme tips at the commencement of the rounding of the margin; the curvature of the posterior zone of the petal being greater than the anterior. The odd anterior petal is straight. The breadth of the poriferous zone diminishes rapidly at the apical, and less rapidly at the outer, extremity of the zone. At the widest portion of the petal the breadth of the poriferous zone is about half the breadth of the interporiferous area, whilst rather nearer the apex the width of the poriferous zone is somewhat greater than this. The inner pores of a zone are round, and the outer pores more or less elongate, the pair being united by a deep groove. The divisional septa are narrow, and ornamented by a single row of granules. The extrapetalous portion of the poriferous zone is not sunken in a groove; and the zones of each ambulacrum on the actinal surface converge rapidly in the neighbourhood of the peristome. The interporiferous areas are flush with the surface of the test, both within and without the petal, and their ornamentation is similar to that of the interradial areas.

The anterior interradial areas have a small degree of convexity, and are not disturbed by any special tumidity whatever. In the posterior part of the lateral interradia a slight tumidity is developed, which culminates towards the margin and prominently affects the marginal contour. The odd posterior interradium is largely tumid along the median line, and especially towards the posterior extremity, where it becomes well rounded and almost bombous, forming a conspicuous rostration. On the actinal surface the odd posterior interradium shows a slight tumidity along the median line, especially in the neighbourhood of the periproct; and the tumidity extends partly round that aperture on either side of the median line, excepting the outer margin; in this manner the rostrate character is greatly emphasized.

The ornamentation of the test is unfortunately more or less destroyed in our specimen. The primary tubercles are small, numerous, and uniform, entirely sunken in small scrobicules; and the intermediate spaces are prominent, confluent, and, although usually narrower than the width of a scrobicule, appear to be comparatively wider than in *E. Sindensis.* The increase in the size of the ornamentation on the actinal surface is very slight.

The peristome is large and pentagonal, with the transverse diameter greater than the longitudinal, and its position is slightly excentric in front. The whole of the actinal surface of the test has suffered to such an extent from weather action that no observations are possible beyond those of the most general character. The anterior pair of bourrelets were probably more developed than the others, and the phyllodes were apparently quite insignificant, the ambulacrum being remarkably contracted in this species, and without presenting the slightest phyllode-like expansion in the vicinity of the peristome. Four or five inner pores are present in each column, sometimes borne on plates equal in size to the adjacent plates, and sometimes on a small intercalated wedge-shaped plate, which does not reach the outer margin of the ambulacral zone (see fig. 15). On all the ambulacral plates of this inner portion of the zone a small prominence or lip occurs over the pore, which gives a sort of imbricating character to the plates.

The periproct is large, transversely oval, and situated entirely on the actinal surface; a slight rounding of the posterior rostration being visible on the outer margin of the aperture when the test is viewed from below.

Remarks. The nearest ally of this species is probably *E. Sindensis.* It is, however, distinguished from that form by the more elongate test with a more oval margin—which is also more contracted and more definitely rostrate behind—by its lower apex, and by the more uniform curves of the dorsal convexity. It is still more conspicuously characterized by the highly flexuous ambulacral petals, by the general concavity of the actinal surface, by the more anteriorly excentric peristome, and by the different proportions of the surrounding parts of the test. After careful study we have considered that these differences warrant the separation of the form above described as a distinct species.

Dimensions.

	millim.
Length of the test	98·5
Breadth of the test	76·5
Height of the test	39·5
Greatest width of the postero-lateral petal	10
Width of the interporiferous area at this place	5·25

The proportion of breadth to length, 0·77 : 1.

" " height to length, 0·40 : 1.

Locality. In the Khirthar series of strata: River-section, east of Trak. Survey-number $\frac{G\ 226}{103}$.

Illustrations of the Species in Plate XXX.

Fig. 12. Abactinal view of the test: natural size.
13. Actinal view of the test: natural size.
14. Longitudinal profile of the test: natural size.
15. Peristomial extremity of the left anterior ambulacrum: magnified.

8. ECHINOLAMPAS JUVENILIS, *Duncan & Sladen*. Plate XXX, Figs. 16–18.

Test of small size. Marginal contour suboviform, well rounded in front, the greatest breadth occurring in the posterior part of the lateral interradia, where the test is slightly tumid; from thence the outline contracts rather rapidly along the prominent and well-marked rostration. The greatest breadth is proportional to the length as 0·81 : 1. The dorsal surface is regularly convex, and the height is rather less than one half the length.

The apical disk corresponds with the summit of the test and is excentric in front, the anterior and the posterior portions of the median longitudinal line being proportional as 19 : 35 or as 1 : 2 approximately. Seen in longitudinal profile, the dorsal convexity is of comparatively low elevation, the inclination of the anterior slope is very slightly greater than that of the posterior, and the anterior margin is very thick, tumid, and well rounded. The posterior slope passes with a well-rounded curve over the posterior rostration. The transverse profile shows a faint tendency towards a subconoid form in the outline of dorsal convexity, and the margins are thick and tumid. The actinal surface is somewhat concave and most depressed along a transverse line passing through the peristome. The surrounding actinal portions of the test are tumid, their curvature merging uninterruptedly into that of the margins.

The ambulacral petals are long, straight, and narrow, and present no expansion. The posterior petals are the longest, and the odd anterior petal is slightly narrower than the others. The poriferous zones are unequal; the anterior zone of the posterior petals and the posterior zone of the anterior petals being longer by 6–8 pairs of pores than their companion zones in the respective petals. The pores are subequal; the inner pores round, and the outer pores also round or slightly oval transversely. The pores are united by a faint groove, and the divisional septa develop midway a slight granule-like prominence. The extrapetalous portion of the zone is flush with the test, and its course is not marked by any channel or depression.

The interporiferous areas are flush with the level of the test in the petaloid portion of the ambulacrum; but there is a slightly tumid swelling of the area, faintly affecting also the adjacent parts of the interradia, discernible in the marginal contour. In the anterior interradial areas a slight tumidity is developed along the median line of the actinal portion of the area. The lateral interradia are tumid marginally, especially in the posterior column of the area; and the odd posterior interradium is very tumid and bombous on the outer part of the median line over the posterior rostration, and is also tumid to a considerable degree along the median line on the actinal part of the area.

The ornamentation of the test is nearly wholly obliterated by weathering; where traces are preserved, the primary tubercles appear to be moderately well spaced, with the intermediate parts comparatively broader, and the miliary granulation also comparatively larger than usual.

The peristome is large, transversely oval, and is slightly excentric in front. A faint swelling is present in the anterior peristomial plates, but otherwise bourrelets are not developed. Incipient phyllodes are distinctly formed.

The periproct is large, transversely oval, and entirely upon the actinal surface, the plane of the orifice, however, being at a small angle to the plane of the actinal area, in consequence of the median tumidity of the actinal portion of the odd interradium.

Remarks. The alliance of this form is exceedingly close to *E. silensis*, Desor, and we feel some hesitation in separating it specifically. It is distinguished by the more pyriform outline, which is more contracted posteriorly and with a more prolonged rostration. The height is rather less and the dorsal surface more convex, the posterior interradium sloping continuously from the apex, and not being so high or fully rounded as in *E. silensis*, and the angle inclosed by the anterior pair of petals is also perhaps rather smaller. The actinal surface appears to be more generally concave and the peristome slightly more excentric. The miliary granulation is also comparatively coarse for the genus, whilst that of *E. silensis* is described as very fine. On the cumulative weight of these numerous small differences, we prefer to place the solitary specimen from Sind provisionally as a separate species, rather than draw the momentous conclusion of a more direct faunatic alliance upon such scanty material.

Dimensions.

	millim.
Length of the test	27
Breadth of the test	22
Height of the test	13
Greatest width of the postero-lateral petal	2·5
Width of the interporiferous area at this place . . .	1·35
Transverse diameter of the peristome	5·5
Longitudinal diameter of the peristome	3·25
Transverse diameter of the periproct	5·75
Longitudinal diameter of the periproct	3·25

The proportion of breadth to length, 0·81 : 1.

" " height to length, 0·48 : 1.

Locality. In the Khirthar series. Baili, west of Tóng. Survey-number $\frac{G\ 304}{23}$.

Illustrations of the Species in Plate XXX.

Fig. 16. Abactinal view of the test: natural size.

17. Actinal view of the test: natural size.

18. Longitudinal profile of the test: natural size.

9. **Echinolampas lepadiformis**, *Duncan & Sladen.* Plate XXXI, Figs. 6–10.

Test of small size. Marginal contour roundly oval, slightly more pointed posteriorly than anteriorly. The greatest breadth is nearly nine tenths of the length, or as 0·89 : 1. The dorsal surface is regularly convex, springing from the comparatively thin margins. The greatest height is one half the length, or as 0·51 : 1, measured from the resting-plane of the test. The actinal surface is concave, the resting-plane of the test being close to the margin, which is thin and overhanging, merging imperceptibly into the dorsal curve. There is a faint carination along the median line of the posterior interradium. Seen in longitudinal profile, a slight flattening of the convexity is apparent at the apex, and the curvature anteriorly is fuller and more tumid than posteriorly, the posterior curve being more extended and gradual. The transverse profile is faintly but distinctly subconoid in outline.

The apical disk is excentric in front, its distance from the anterior margin being about three tenths of the length of the test. The anterior pair of generative pores are closer together than the posterior pair; and the ocular pores are small and microscopic.

The ambulacral petals are long, narrow, and subelliptical in outline. The anterior pair and the odd anterior petal are subequal, both in length and breadth. The poriferous zones are narrow and uniform; the anterior zone in the anterior pair, and the left zone in the odd anterior petal being the shortest by a few pairs of pores. The posterior petals are longer and also slightly narrower than the anterior petals; and the anterior zone of the posterior petal is longer by five or six pairs of pores, and is distinctly broader than the companion posterior zone. Both the inner and the outer series of pores are round, and those of a pair are united by a conjugating furrow, the adjacent furrows being separated by well-defined costæ, bearing a single line of miliary granules. The interporiferous areas are very faintly tumid. The interradial areas of the test are uniform and undisturbed by any sudden tumidity on the abactinal region, excepting the decided carination of the odd posterior interradium previously mentioned. At the margin of the actinal surface there is a slight tumidity in the posterior column of the lateral interradia, but of very small development.

The peristome is large and excentric in front, transversely subpentagonal, with rounded angles. There is a high vertical wall extending upwards, covered with a uniform granulation, and the buccal pores of the ambulacra open conspicuously below the margin. Bourrelets are present, and the phyllodes are well developed for this genus. The widely extended concavity in which the peristome is situated is remarkable.

The periproct is large, transverse, and inframarginal, the plane of the orifice having apparently been at an angle to the actinal surface; but unfortunately the test has sustained fracture in this region.

The ornamentation of the test is uniform, the scrobicules are comparatively large and closely placed, with the intervening miliary granulation large and confluent.

Remarks. This form is unlike any of the other Indian species of *Echinolampas*, and we know of none with which it can be confounded. In longitudinal profile it bears some resemblance to *E. globulus*, Laube; but it differs in the greater breadth, in the less height, in the concavity of the actinal surface, and in the character of the ambulacral petals.

Dimensions. Length of the test 19·5 millim., breadth 17·5 millim., height 10 millim.

Locality. In the Khirthar series of strata:—North by east of Meting. Survey-number $\frac{G\ 280}{161}$.

Illustrations of the Species in Plate XXXI.

Fig. 6. Abactinal view of the test: natural size.
7. Actinal view of the test: natural size.
8. Longitudinal profile of the test: natural size.
9. Abactinal area, showing the ambulacral petals and apical disk: magnified.
10. The peristome and surrounding portions of the test: magnified.

10. ECHINOLAMPAS ÆQUIVOCA, *Duncan & Sladen.* Plate XXXII, Figs. 1–3.

There is a specimen of *Echinolampas* in the collection, which is unfortunately so much crushed and damaged by weather-action that a complete description is impracticable. The characters, however, are sufficiently remarkable to distinguish the form readily from the other members of the genus from the Khirthar series of strata, and on this account we have accorded to it a specific name. The following points may be noticed:—

The test is of moderate size, subdepressed and elongately oval in marginal contour, the breadth being seven eighths of the length. The dorsal surface is low, but convex. Seen in longitudinal profile the anterior slope is a full and well-rounded curve (probably emphasized in our specimen by crushing); and the posterior slope is gentle, passing with a well-rounded sweep over the slight posterior rostration, and terminating precipitously at the posterior extremity.

The apical disk is very excentric in front, and the ambulacral rosette is comparatively small, and, owing to the shortness of the posterior petals, has a very excentric appearance generally. The odd anterior ambulacrum is the shortest and narrowest; the anterior pair of petals are equal to or slightly longer than the posterior pair, and are decidedly the broadest. The outline of the petals is elliptically lanceolate, expanding rapidly from the apical extremity, and converging towards the outer extremity. The poriferous zones are unequal, especially those of the anterior pair of petals, in which the anterior zone is shorter by ten or eleven pairs of pores than the companion zone. The posterior zone of the posterior petals is similarly shorter than its companion; but to what extent the condition of the specimen does not enable to be determined accurately. The breadth of the zone is very uniform throughout, and is only very slightly broader midway than at the outer extremity. The inner pores are round or faintly oval transversely, and the outer larger and transversely elongate, becoming comma-shaped on the outer portion of the zone. The pores of a pair are united by a well-defined conjugating furrow; and the position of the pairs is oblique in relation to the median line of the petal, the obliquity increasing towards the outer extremity of the zone, where also the pores of a pair exhibit a faint tendency to stand at an angle in relation to one another. The petals are flush with the surface of the test; and the interporiferous area is about two and a half times the width of the poriferous zone at its widest part, but very little more than one and a half at the extremity of the petal, measured at the termination of the short anterior zone. The ornamentation of the interporiferous area is similar to that of the rest of the abactinal surface of the test, and consists of small primary tubercles sunken in small, equidistantly-spaced scrobicules, with the intervening spaces rather broad, but less than the diameter of the scrobicules, the structure being remarkably confluent, almost to the complete obliteration of the component granules; and the margins of the scrobicules have a slightly bevelled appearance. In the region of the ambitus the scrobicules are more closely placed.

Nearly the whole of the actinal surface is either obscured or destroyed. There is a considerable and widely extended depression towards the peristome, the position of which is more or less excentric in front. The periproct is small, transversely oval, and encroaching on the margin.

Remarks. This species is closely allied to *E. Jacquemonti*, d'Archiac and Haime; but differs in the form of the test, and in the smaller and comparatively more excentrically-placed ambulacral rosette; whilst the general height and tumidity of the sides also appear wanting in our form, and the concavity of its actinal surface is very much greater than in *E. Jacquemonti*.

Dimensions. Length of the test 40 millim., breadth 35 millim., height 17·5 millim. (somewhat crushed).

Locality. Khirthar series of strata:—Trak Hill, seventeen miles south of Búla Khán's Thána. Survey-number $\frac{G\ 226}{87}$.

Illustrations of the Species in Plate XXXII.

Fig. 1. Abactinal view of the test: natural size.
2. Actinal view of the test: natural size.
3. Longitudinal profile of the test: natural size.

11. ECHINOLAMPAS, sp. (Junior). Plate XXXI, Figs. 1–5.

Amongst the rich collection of Echinolampads from the Khirthar series, there are two unquestionably in a premature stage of development, but which, from their striking character, we are unable to refer to any of the species previously described. The test is of small size, elongate, and subcylindrical, with an elongately oval marginal contour, full and well-rounded in front, slightly widest across the posterior third, thence rather rapidly contracted and pointed posteriorly. The breadth is proportional to the length as 0·75 : 1. The dorsal surface is convex along the longitudinal axis of the test, and the margins are full and tumid. The height is rather more than half the length, being in the proportion of 0·59 : 1. Seen in longitudinal profile the flatness of the dorsal surface is very striking, passing with a well-rounded curve over the anterior extremity, which is continued on to the actinal surface; the posterior curve is more rapid, and terminates above the periproct, forming a rather prominent roof over that aperture. Seen in transverse profile the subcylindrical form is evident, the convexity of all regions being remarkable. The actinal surface is almost as convex as the abactinal. The apical disk is very excentric in front, its distance from the anterior extremity being five sixteenths of the length of the test. There are four well-developed generative pores, and the anterior are much closer together than the posterior pair. The ocular foramina are comparatively large and distant from the disk, as defined by the generative pores.

The ambulacra are petaloid and unequal. The odd anterior is the shortest, and the posterior pair are the longest. All are lanceolate and tapering towards the apex, and more or less convergent at the outer extremity, the odd anterior petal being the least so. In the odd anterior ambulacrum the poriferous zones are equal, each having eleven pairs of pores. The distance of the pores apart in each pair increases from the apex up to the ninth pair and then begins to diminish, this giving the tendency to closure in the petal's outline. All the pores are round, and those of a pair are united by a well-defined conjugating furrow. The antero-lateral petals are equal in breadth to the odd anterior petal or perhaps the slightest shade wider. The poriferous zones are unequal, the anterior zone being shorter than the posterior; the number of pairs of pores in each is nine and thirteen respectively; and the posterior zone forms a sweeping well-rounded curve, convexity backwards. The posterior petals are a shade wider than the anterior pair, and are considerably longer. The poriferous zones are unequal, the anterior being the longest. The number of pairs in each zone is seventeen in the anterior and fourteen or fifteen in the posterior. All the petals terminate at the commencement of the rounding of the margin, and are consequently entirely confined to the dorsal area.

The peristome is very large and subelliptical in shape, placed transversely, the lateral extremities being acutely angular. The breadth is 4 millim., and the length 2 millim. It is excentric in front, but much less so than the apical disk. There is no peristomial wall or lip, and no traces of phyllodes or bourrelets have yet been developed.

The periproct is large and transversely oval; it is inframarginal, with the plane of the orifice nearly at an angle of 45° to the plane of the actinal surface, its position being in the rounding between the ambitus and true actinal area. The posterior interradium forms a prominent roof over the upper margin of the opening.

Remarks. Owing to the juvenile character of the tests under notice, we have abstained from assigning any name to them until a further supply of material can be studied. From the fact that we are unable to associate them with the young of any of the forms described in the preceding pages, it would seem to be probable that they may belong to a distinct species.

Dimensions. Length of the test 16 millim., breadth 12 millim., height 9·5 millim.

A second test from the same locality is somewhat larger; but has been too much crushed for measurement.

Locality. In the Khirthar series of strata:—Baili, west of Tóng. Survey-number $\frac{G\,304}{28}$.

Illustrations of the Species in Plate XXXI.

Fig. 1. Abactinal view of the test: natural size.
2. Actinal view of the test: natural size.
3. Longitudinal profile of the test: natural size.
4. Abactinal area, showing the ambulacral petals and apical disk; magnified.
5. The peristome and surrounding portions of the test: magnified.

There is a very small specimen, measuring 10 millim. in length, from a locality five miles east-fifteen-north of Ghatana Trig station near Jhímpír (Survey-number $\frac{G\,280}{106}$), which we refer with some hesitation to the same form as the above. This form accords in shape, proportions, and general characters with that above described; but is remarkable for the immature state of the odd anterior ambulacrum. The example is obviously too immature for accurate determination.

12. ECHINOLAMPAS, sp. Plate XXXVI, Figs. 22 & 23.

There is a single specimen of a small *Echinolampas* in the collection, which is certainly distinct from the other forms we have described; but which is unfortunately so much obscured by matrix that a complete description is impossible.

The test is subdepressed, with a rotund marginal contour, the greatest breadth being between the posterior part of the lateral interradia. The length is about 29 millim., and the estimated breadth 27 millim. The height is about 14 millim.; and the dorsal surface seen in longitudinal profile presents a remarkably regular convexity, sloping uniformly anteriorly and posteriorly, and springing direct from the ambitus, which is well, but rather abruptly, rounded on to the actinal surface.

The apical disk is excentric in front; it is comparatively large, and the central portion, which is occupied by the madreporiform body, is slightly elevated. The ambulacra are comparatively narrow, but conspicuously petaloid, the zones of a petal converging considerably towards the outer extremity. The posterior petals are rather longer than the anterior pair. The poriferous zones are unequal, the left zone of the odd anterior ambulacrum and the anterior zone of the antero-lateral petals, and the posterior zone of the postero-lateral petals being shorter than their respective companions; the inner series of pores are round and the outer pyriform, with the pores of a pair rather wide apart, and united with a well-defined conjugating furrow. The divisional costæ appear to be smooth and devoid of tubercles or granules. The width of the poriferous zone is rather less than half the width of the interporiferous area at its widest part. The other structures of the test are obscured.

Remarks. This species is interesting from its occurrence in the white limestone in company with great numbers of *Hemiaster digonus*; and no other species of *Echinolampas* are associated with it. On these accounts we consider it desirable to record the presence of this form; and a drawing of the solitary example has been given in Plate XXXVI. for future reference, and to facilitate identification when a further supply of material may enable a complete diagnosis to be furnished.

Locality. In the Khirthar series of strata:—Bolári bridge on the Báran rivers, south-west of Kotri. Survey-number $\frac{G\ 280}{85}$.

Illustrations of the Species in Plate XXXVI.

Fig. 22. Abactinal view of the test: natural size.
23. Longitudinal profile of the test: natural size.

Subfamily ECHINANTHINÆ.

Genus ECHINANTHUS, *Breynius*, 1732.

(See *antea*, p. 12, Part i.)

1. Echinanthus intermedius, *Duncan & Sladen.* Plate XXXII, Figs. 4–8.

Test of medium size. Marginal contour elongately oval, well-rounded in front, more contracted and produced behind, where the test is subrostrate and truncate. The greatest breadth is behind the centre of the test, and equals about four fifths of the length. The dorsal surface is depressed and slightly convex; the greatest height, which lies between the extremities of the posterior petals, is but very little more than two fifths of the length. Seen in longitudinal profile, the anterior slope is a low gradual declivity passing abruptly with a well-rounded curve over the tumid anterior margin; and the posterior slope is much shorter and more rapid, terminating abruptly at the posterior truncation. The transverse profile shows the dorsal area slightly subconoid, with the margins thick, tumid, and well-rounded. The actinal surface is tumid laterally, with a well-defined depression corresponding with the longitudinal axis of the test in front of the peristome, and behind dividing into two diverging depressions which bound the more or less tumid median region of the odd posterior interradium, and correspond with the course of the posterior ambulacra.

The apical disk is excentric in front, its distance from the anterior margin being rather more than one third of the length of the test, or measuring 11 millim. in an example 30 millim. long.

The ambulacra are conspicuously petaloid in outline, lancet-shaped and almost closed at the outer extremity, simulating in a remarkable manner the ambulacral rosette of *Ilarionia Sindensis.* The posterior petals are longer than the three anterior petals, which are equal in length, but the odd anterior ambulacrum is the narrowest, and is more widely open at the extremity and much less petaloid than the others. The poriferous zones are equal and narrow, and the pores are subequal, the inner series round, and the outer series with a tendency to become oval; the pores of a pair are united by a faint conjugating furrow, and adjacent pairs separated by low ill-defined costæ, which probably bore three or four rather large isolated granules. The interporiferous areas are rather less than twice the width of the poriferous zone in the posterior pair of petals, but are rather more than twice the width of the poriferous zone in the anterior pair of petals.

The peristome, though excentric in front, is nearer to the centre than the apical disk; it is large, transverse, and pentagonal, the transverse diameter being twice that of the longitudinal diameter. There is a faint tendency towards thickening at the margin, but bourrelets are not developed. In the ambulacral areas the peristomial plates exhibit conspicuously the companion pair of buccal pores; and the poriferous zones in the vicinity of the peristome present a few well-defined pores, some of which are internal to, and alternating with, the main series, and suggest the rudiments of an incipient phyllode.

The periproct is large and elliptical, placed longitudinally at the summit of the posterior rostration, of which it occupies a large portion of the surface. The length of the aperture is nearly twice the measure of its transverse diameter. The inferior margin of the posterior rostration is full and well-rounded; and a more or less tumid development at the margin on either side the median line gives emphasis to a slight depression beneath the periproct. Actinally the odd posterior interambulacrum is tumid near the margin, a character which gradually diminishes towards the peristome.

The ornamentation of the test is almost entirely destroyed; from what remains it appears to have been small, crowded, and very uniform throughout.

Remarks. It is not without much hesitation that we have given a name to this solitary and badly preserved specimen. In many respects it resembles in a remarkable manner *Ilarionia Sindensis*, which in the characters of the ambulacral rosette it may almost be said to mimic. The depressed and differently shaped test, the characters of the peristome, of the incipient phyllodes, and of the actinal surface generally are quite distinct and unconformable with *Ilarionia*. The species under notice constitutes, however, a striking link between that genus and *Echinanthus*.

Dimensions.

	millim.
Length of the test	30
Breadth of the test	24·5
Height of the test	13

Locality. In the Khirthar series of strata:—Baili, west of Tóng. Survey-number $\frac{G\ 304}{23}$.

Illustrations of the Species in Plate XXXII.

Fig. 4. Abactinal view of the test: natural size.
5. Actinal view of the test: natural size.
6. Longitudinal profile of the test: natural size.
7. Transverse profile, seen from behind: natural size.
8. The peristome and surrounding portions of the test: magnified.

Genus ILARIONIA, *Dames*, 1877.

Test elongately oval or oviform, subdepressed, more or less convex above, flat or slightly convex below; margins very thick and tumid.

Apical disk compact, excentric in front.

Ambulacra petaloid; petals short, unequal, lancet-shaped, contracting towards the outer extremity, which is nearly closed. Poriferous zones equal, pores round or slightly oval; pores of a pair united by a conjugating groove.

Peristome decagonal, or subpentagonal, with raised rim and special tubercles more or less developed. No floscelle.

Periproct elongately oval, situated on the upper part of the vertically truncate posterior extremity.

Ornamentation very uniform; tubercles small, sunken in deep scrobicules, closely placed, miliary granulation confluent and compact. A more or less well-defined band, devoid of scrobicules, present between the peristome and periproct.

The distinctive character of *Ilarionia*, as pointed out by Dr. W. Dames, consists in the peculiar structure of the peristome. This was described by him * as having a decagonal outline which might be represented by an equilateral pentagon from which the angles had been abruptly truncated by short lines; the long lines, corresponding with the interambulacral areas, being granular, whilst the short lines, which would correspond with the ambulacra, are smooth. Furthermore, at the junction of the long and short lines a small smooth tubercle is present, the peristome being consequently surrounded by ten of these protuberances. The margin of the aperture is raised and extends far upwards into the body-cavity of the test, the walls corresponding with the interambulacral areas being finely granulated. In other respects the genus unites in a remarkable manner the characters of *Echinanthus* and *Pygorhynchus*.

1. Ilarionia Sindensis, *Duncan & Sladen*. Plate XXXII, Figs. 9–18.

Test of small or medium size. Marginal contour elongately oval, well-rounded in front, more contracted behind, and vertically truncate at the posterior extremity. The greatest breadth lies usually midway between the extremities, and is about seventeen twentieths of the length, or in the proportion of 0·85 : 1. The dorsal surface is moderately high and flatly convex; the height being rather more than three fifths of the length, or (in the type specimen) as 0·63 : 1. The position of the apical summit or greatest height of the test is subject to variation, and may either correspond with the apical disk, which is excentric in front, or may be situated between the extremities of the posterior petals, and consequently excentric behind. There is likewise a conformable variation in the longitudinal profile of the test. In the type the outline is very cylindrical, the median portion of the abactinal surface being almost flat, passing with a well-rounded curve over the anterior extremity, and sloping down posteriorly with a gentle curve till it meets the abrupt posterior truncation, which is vertical. In tests having the apical summit more pronounced, the flatness of the abactinal surface gives place to a gentle declivity on either side of the apical prominence. Seen in transverse profile the outline is a depressed oval, more or less uniformly tumid. The actinal surface is more or less convex, with a low ridge of greatest convexity corresponding with the longitudinal axis of the test, which is, however, scarcely apparent in front of the peristome. The margins are thick, giving the idea of deep sides, and are moderately tumid. The passage from the lateral on to the actinal surface is well-rounded and uninterrupted, excepting beneath the posterior truncation, where the rounding is much sharper and subangular.

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* Die Echiniden der vicentinischen und veronesischen Tertiärablagerungen, p. 34. Palæontographica, N. F. v. 1 (xxv.).

The apical disk is excentric in front, its distance from the anterior extremity of the test being proportional to the longitudinal axis as 0·37 : 1. The structure of the disk is compact, with four generative pores, the anterior pair more closely placed than the posterior pair, and the central portion slightly elevated and covered with the punctures of the madreporiform body.

The ambulacral petals are short and unequal, the odd anterior ambulacrum being slightly the shortest and narrowest, and the posterior pair the longest. The outline of the petals is lancet-shaped, the poriferous zones diverging rather rapidly from the apex, and attain the greatest width at a point nearer the apex than midway between the extremities of the petals; from thence the zones converge towards the extremity of the petal, which is nearly closed. The poriferous zones are equal and narrow, increasing very slightly in breadth as they proceed outward, but again contracting slightly for a short distance at the outer extremity. The inner series of pores are round, and the outer series are subequal or slightly larger and show the faintest tendency towards becoming comma-shaped; the pores of a pair are united by a well-defined conjugating furrow, and the divisional costæ form narrow ridges, indefinitely granulated. The interporiferous areas have a faintly tumid appearance in consequence of the poriferous zones being slightly sunken in a shallow groove; the width of the area at its greatest breadth is about three times the width of a poriferous zone or even rather more, whilst at the outer extremity of the petal it is scarcely more than the width of the poriferous zone. The extrapetalous continuations of the ambulacra are invisible in the ornamentation of the test until close to the peristome, where a few single pores are discernible. The ornamentation of the interporiferous area is similar to that of the interradial portions of the test, and consists of small primary tubercles in sunken scrobicules, closely and equidistantly placed, the intermediate space being less than the diameter of the scrobicules and having its miliary granulation entirely confluent. The character of the ornamentation is very homogeneous throughout the test. On the actinal surface a rather narrow, but usually well-defined, band of pitted structure extends from the peristome up to the posterior extremity of the test, on which no scrobicules and primary tubercles occur.

The peristome is large and excentric in front, lying beneath the apical disk. It is transversely oval or subdecagonal in outline, having a raised rim around its margin, and the peristomial wall extending vertically upward into the body-cavity. The portions of this wall which correspond to the interambulacral areas are uniformly granulated, and the portions corresponding to the ambulacra are comparatively narrow strips. On the raised peristomial rim there is a small, feebly developed granule on the ambulacral portion of the rim at its junction with the apparently continuous interambulacral portion; there are thus two granules near together opposite each ambulacral area. These granules, however, are not always clearly discernible in every specimen and are not always equally developed in each individual. Outside the peristomial ring the poriferous zones of the ambulacra are represented by three or four pores closely placed in uniserial line, and there is no tendency to form a phyllode.

The periproct is elongately oval or elliptical, placed longitudinally at the upper part of the vertical posterior truncation of the test; its length is twice its breadth, and is about equal to the transverse diameter of the peristome. Above the periproct the odd posterior interradium forms a slightly tumid keel along the outer portion of the median dorsal line, but no roof whatever is formed over the aperture; and when viewed abactinally from behind, the sides of the test seem to be nipped-in at the sides of the periproct, which causes this aperture to appear to be placed at the extremity of a somewhat pointed prolongation of the test. Beneath the periproct there is no channel, although a very faint median depression may sometimes be noticed; and the inferior margin of the posterior truncation is full, tumid and abruptly rounded, joining the prominent median tumidity of the actinal portion of the odd posterior interradium.

Variations. The chief variations noticed in this species are those which affect the marginal contour, the relations of length to breadth, the position of the apical summit of the test, and the consequent modification in the longitudinal profile. These points have been referred to above, and the other details of structure appear to be very constant. An elongate variety, produced and contracted posteriorly, and with the apical summit excentric behind, is shown in Figs. 15 and 16; and a small subrotund variety, which appears to be uncommon, with the apical summit corresponding with the apical disk, is given in Figs. 17 and 18.

Remarks. Although the Indian species does not show the peculiar characters of the peristome in such a marked manner as the type form of the genus, *I. Beggiatoi*, Laube, sp., we do not hesitate to include the present Echinoids in the same category. The two species are well distinguished from other *Echinanthinæ* and cannot be mistaken.

Dimensions.

	a. millim.	*b.* millim.	*c.* millim.	*d.* millim.
Length of the test	27	29	22	18·5
Breadth of the test	23	23·5	20	16
Height of the test	17	17·5	13	13

Localities. In the Khirthar series of strata:—i. Baili, west of Tóng. Survey-number $\frac{G\ 304}{23}$.

ii. Trak hill, seventeen miles south of Búla Khán's Thána. Survey-number $\frac{G\ 226}{87}$. (A small example.)

Illustrations of the Species in Plate XXXII.

Fig. 9. Abactinal view of the test: natural size.
10. Actinal view of the test: natural size.
11. Longitudinal profile of the test: natural size.
12. Transverse profile, seen from behind: natural size.
13. Abactinal area, showing the petals and apical disk: magnified.
14. The peristome and surrounding portions of the test: magnified.
15. Abactinal view of the test of another specimen, an elongate variety natural size.
16. Longitudinal profile of the same test: natural size.
17. Abactinal view of the test of a small round example: natural size.
18. Longitudinal profile of the same test: natural size.

Genus CASSIDULUS, *Lamarck*, 1801.

(See *antea*, p. 65, Part ii.)

1. Cassidulus subinvaginatus, *Duncan & Sladen*. Plate XXXIII, Figs. 17–20.

Test rather small, elongate, and subdepressed. Marginal contour elliptically oval, more contracted in front than behind, where the extreme posterior margin is slightly truncated. The greatest width of the test is nearly three fourths of the length, and is situated midway across the test, or perhaps occasionally somewhat behind this line. The greatest height is nearly one half the length. The dorsal surface is convex, and higher in the two posterior thirds of the test than in the anterior third, the latter portion of the test sloping gently from the apical disk to the margin, and the posterior extremity sloping abruptly at a high and almost precipitous angle down to the margin. The longitudinal profile shows an abactinal curvature of low convexity, rising gradually and slowly from the anterior margin, rather flattened at the apex, and then descending sharply and precipitously at a high angle at the posterior extremity. The transverse profile shows a regular convex curve, and the margins are comparatively thick, tumid, and well rounded. When viewed from the side, the ambitus is seen to be somewhat fuller or more tumid actinally in the region midway between the extremities. The actinal surface is concave, with a tendency to form a longitudinal trough, the lateral portions of the test being specially tumid.

The apical disk is small and slightly excentric in front. There are four small genital pores, the anterior pair being nearer together than the posterior pair. The ocular plates are small, and indistinguishable in the state of the preservation of our material. The ambulacral petals are unequal, the anterior pair being rather shorter than the others. Their external outline is gracefully lanceolate, contracting slightly towards the outer extremity, where, however, they are widely open, and terminate at some distance from the margin. The poriferous zones are equal and broad, being only a little narrower at the widest part than the breadth of the interporiferous area. The inner pores are round, and the outer pores pyriform, the pair being united by a well-defined furrow; and each pair separated from the neighbouring pair by a broad costal ridge. The poriferous zones diminish only slightly in breadth towards the outer extremity. The interporiferous area is lanceolate in outline, slightly narrower at the outer extremity than across the middle of the petal, and converging rapidly towards the apical disk. We are unfortunately unable to describe in detail the character of the floscelle, as in one of our specimens that portion of the test is obscured by matrix, and in the other is so greatly weather-worn that nothing but the general Cassidulid character is discernible. The bourrelets do not appear to have been very prominent.

The ornamentation of the abactinal area of the test consists of small primary tubercles, sunken in small, uniform, rather widely spaced scrobicules, the intermediate portion of the test being coalescent and comparatively broad, which gives a somewhat coarse appearance to the ornamentation. On the actinal surface the scrobicules are very large, and the tubercles are placed near the side of the cavity. In the neighbourhood of the median longitudinal line there is much pitted structure and coalescence in place of scrobicules.

The peristome is slightly excentric in front; unfortunately its form is indistinguishable in our specimens.

The periproct is situated in a long, narrow, elliptical depression or slit, extending from the upper extremity of the posterior declivity nearly down to the margin. In the test below the periproct there is a slight trough or channel, which disappears on the rounding of the margin. There is no hood or overhanging prominence above the periproct, the test appearing as if slightly pinched together and angular there, and the lateral margins of the periproct-slit are slightly impressed or bent inwards.

Remarks. This species is much more elliptical than the allied form, *C. ellipticus*, from the Ranikot series, the test being more almond-shaped, more contracted anteriorly, with the apical disk more excentric, and the character of the posterior rostration and of the periproct also different. The forms are distinctly separate.

Dimensions.

	millim.
Length of the test	23
Breadth of the test	17
Height of the test	11

A second specimen is of the same size, but somewhat crushed.

Locality. In the Khirthar series:—Baili. west of Tóng. Survey-number $\frac{G\,304}{23}$.

Illustrations of the Species in Plate XXXIII.

Fig. 17. Abactinal view of the test: natural size.
18. Actinal view of the test: natural size.
19. Longitudinal profile of the test: natural size.
20. The test, seen from behind: natural size.

Genus RHYNCHOPYGUS, *d'Orbigny*, 1801.

(See *anteà*, p. 67, Part ii.)

1. Rhynchopygus Calderi, *d'Archiac & Haime*, sp. Plate XXXIII, Figs. 1–6.

Eurhodia Calderi, *d'Archiac & Haime, Descrip. Anim. foss. du groupe numm. de l'Inde*, p. 352, pl. xxx, fig. 19.

Test of moderate size. Marginal contour suboval, rather flattened at the sides, somewhat elliptically rounded in front, and distinctly truncate posteriorly, where it is also slightly reenteringly curved. In some examples the greatest width is in a line with the extremities of the postero-lateral petals; and a somewhat angular protuberance is produced in the contour by the rather rapid rounding of the margin from this point until it joins the posterior truncation. The breadth is usually about three fourths of the length; but in some cases the disproportion is slightly less. The dorsal surface is moderately high, with a subcarinate or rounded ridge along the longitudinal axis, from which the sides are inclined roof-like. The vertical height at the summit is rather more than one half the length. The apical summit of the test is excentric in front; and when seen in longitudinal profile the dorsal surface shows a more rapid anterior than posterior slope, the disparity, however, being variable and dependent on the greater or less excentricity of the summit.

The transverse profile exhibits an arch-like contour, produced by the longitudinal carination of the test. The margin is tumid, but less so posteriorly, and more or less conspicuous protuberances are present at the posterior third and near to the posterior truncation. When seen in profile, the ambitus presents a graceful curve, in consequence of the anterior part of the test being on a slightly higher level than the sides; and there is a corresponding upward slope posteriorly, starting from the protuberance on the margin, which stands in line with the extremities of the postero-lateral petals. The anterior portion of the dorsal surface is rather more sharply carinate than the posterior portion, which is frequently more rounded. The longitudinal keel is terminated posteriorly by a prominent lip, which overhangs the periproct. The actinal surface is concave, a more or less distinct longitudinal trough being frequently produced.

The apical disk is small and inconspicuous, usually a little in advance of the summit of the test. The four small genital plates have moderately large pores, which are almost equidistantly spaced. The ocular plates are very minute; those in connexion with the odd and the anterior pair of petals lie between and separate their neighbouring genital plates; whilst those in connexion with the posterior pair of petals are placed on the inner side of the posterior genital plates, and are separated from one another by an extension of the madreporiform body, which also occupies the whole of the central portion of the disk.

The ambulacral petals are flush with the surface of the test and unequal. The odd anterior ambulacrum is large, broad, open anteriorly, and has broad poriferous zones; the line of the inner pores is nearly straight, and that of the outer pores forms a curve, in consequence of the pairs of pores being wider apart midway upon the petal than at the extremities. The inner pores are round, and the outer pores elongate or comma-shaped; with the connecting furrow very narrow and difficult to make out, and often appearing to be obliterated before reaching the inner pore. The divisional septa are broad, and ornamented with one or two primary tubercles in sunken scrobicules, rather smaller than those in the interporiferous area. The interporiferous area is nearly equal to twice the width of the poriferous zone at its widest part; it is ornamented with rather smaller primary tubercles than those upon the interradial plates of the test. The odd anterior ambulacrum terminates at a short distance before the tumid rounding of the margin commences. The antero-lateral petals are much shorter than the odd anterior one, and are a shade narrower at their widest part. On the outer half of their poriferous zones the distance which separates the pores of a pair commences to diminish more rapidly than in the odd anterior petal, in consequence of which the line of the outer pores forms a much more rapid curve, which causes the petal to have a more contracted appearance. The interporiferous area is narrower than in the odd anterior petal, and is somewhat more contracted at the outer extremity, hence the poriferous zones are much closer together in the antero-lateral petals. The postero-lateral petals are about equal in length to the odd anterior petal, and are consequently longer than the anterior pair, with which, however, they correspond in breadth. The poriferous zones do not contract in width so rapidly as in the anterior pair, and the anterior zone of each postero-lateral petal usually appears to be somewhat broader than the companion zone of the same petal. The postero-lateral petals terminate about midway between the apical disk and the margin; whilst the antero-lateral petals extend very slightly beyond the same proportional distance, the space beyond the posterior pair being obviously much greater.

The ornamentation of the interradial portions of the abactinal area is very uniform, and consists of small primary tubercles, sunken in deep small scrobicules, closely placed, and with the intermediate portions coalesced or confluent. On the actinal surface the tubercles and the scrobicules become larger as they approach the mouth, and the former are distinctly perforate. Along the median interradial line in the posterior interradium there is much of the deep-pitted ornamentation characteristic of this genus.

The peristome is large, pentagonal, and longitudinally elongate. It is excentric in front, placed beneath the apical disk, and presents a well-developed floscelle. The bourrelets are subequal, large, deep, conspicuous, and rather angularly subtubercular externally, their whole surface covered with fine uniform granulation. The phyllodes are wide and well developed. They consist of a curved outer line of pores, six to eleven in number, the outline of the phyllode being somewhat lyre-shaped, and an inner series of four to five pores to each zone standing in a more or less straight line; and inside the lines of inner pores are a corresponding number of sphæridia-pits, each companion pore and pit being separated from the neighbouring pair by a more or less developed costal ridge. Indistinct ridges are present in connexion with the series of outer pores. There is a very narrow but distinct channel between each bourrelet, and a pore is present at the outer extremity of each of the long, delicate peristomial plates. The odd anterior phyllode is rather shorter than those of the lateral ambulacra; and a pitted structure occurs along the actinal course of the odd anterior ambulacral area, instead of scrobicules with tubercles as in all the others. These pits extend nearly to the margin, and are smaller and wider apart than in the posterior interradial pitted space mentioned above.

The periproct is above the ambitus, and somewhat away from the margin; the aperture is large, transverse, and overhung by the conspicuous rounded supra-anal projection of the dorsal posterior interradial carination. The portion of the test beneath the periproct is slightly hollowed into a wide but shallow groove, which extends to the rounded margin, and, passing over it, becomes fainter, but still feebly indents the contour of the posterior truncation.

Young form. A small test, 20 millim. in length, presents all the characteristics of the adult, the specific facies being unmistakable.

Variations. A considerable amount of variation within small limits is exhibited by the series of Khirthar specimens. This principally affects:—(1) the marginal contour, by the narrowing of the anterior portion of the test; (2) the dorsal area, by varying degrees of tumidity; and (3) the actinal area, by an increase or a diminution in the amount and distinctness of the longitudinal concavity, together with a greater or less tumidity of the margins.

A singular monstrosity occurs in one of the specimens, which consists in having the odd anterior petal entirely aborted. Notwithstanding this extraordinary defect, the shape of the test maintains its regularity, and the missing ambulacrum is only noticeable on examination. Only three genital pores are present, and only the posterior pair are in their proper position. The specimen is figured on account of this interesting malformation.

Dimensions.

	a millim.	*b.* millim.	*c.* millim.	*d.* millim.	*e.* millim.	*f.* millim.
Length of the test . . .	34	35	42	37	36	20
Breadth of the test . .	26	26	30·5	27	27·5	15
Height of the test . . .	19	18	16·5	20·5	18	10

Width of odd anterior ambulacrum of specimen marked "*a*" . 4 millim.
Width of interporiferous area of the same petal . . . . . . 1·8 „

Localities. In the Khirthar series:—i. Twelve miles east of Kandaira. Survey-number $\frac{G\,226}{149}$.

ii. Aongar hill-scarp, east of Meting Railway-station. Survey-number $\frac{G\,290}{99}$.

Illustrations of the Species in Plate XXXIII.

Fig. 1. Abactinal view of the test: natural size.
2. Longitudinal view of the same test: natural size.
3. The same test, seen from behind: natural size.

Fig. 4. Actinal view of another test: natural size.
5. The peristome and surrounding portions: magnified.
6. Abactinal view of an abnormal specimen, in which the odd anterior ambulacrum is aborted: natural size.

2. RHYNCHOPYGUS PYGMÆUS, *Duncan & Sladen*. Plate XXXIII, Figs. 7–16.

Rhynchopygus pygmæus, *Duncan & Sladen, Pal. Ind., Foss. Echin. Western Sind*, Fasc. ii. (Ranikot Series), p. 61, pl. xv, figs. 5 & 6.

It was remarked in the preceding fasciculus of this work, when describing the Echinoidea of the Ranikot series, that the present species differs from *R. Calderi* mainly in its small size and in the different shape of the test, the disproportion of length to breadth being less, the abactinal area being regularly convex, without any trace of the longitudinal keel, and the posterior truncation barely existing. Furthermore, the peristome is more regularly pentagonal, and the bourrelets are more sharply tubercular than in *R. Calderi*. Excepting these points, the general details of the characters of these small tests accord very closely with the description of *R. Calderi*; and under these circumstances we deem it unnecessary to add to our previous remarks. When studying the few Ranikot specimens of this species we were inclined to think that the form under notice might perhaps prove to be only the young of a variety of *R. Calderi*, or even of *R. Calderi* itself. With the larger series of examples from the Khirthar beds now at our disposal, we consider that such a supposition is almost untenable. The form has been collected at a number of stations; and although a considerable amount of variation is found when the series from different localities are compared, and even amongst individuals from the same locality, we are unable to detect a transition between *R. pygmæus* and *R. Calderi*. Young specimens of *R. Calderi*, of equal size to the present species, present all the characters of the adult form; whilst, on the other hand, examples which appear to be abnormally large for *R. pygmæus* maintain the characters and general facies above defined.

Remarks. The chief variations occurring in this inconstant form are those which affect the relative proportions of length, breadth, and height, together with the position of greatest breadth. A remarkably depressed example occurs, bearing the Survey-number $\frac{G\ 280}{118}$, in which the abactinal area is very low, the margins tumid, the contour prominent anteriorly and truncate posteriorly, and with the periproct wide and exposed. This latter character appears to be owing to damage of the test through weather-wearing. Had this abnormal form been represented only by a solitary example, it would have probably been placed as a well-marked variety. From the fact, however, that other depressed specimens occur from Stations 117 and 112, which appear to us to form a transition with the normal type of the species, any nominal recognition of the variation would seem undesirable. The specimen is drawn in Figs. 15 & 16.

A large and very elongate example comes from Station 111 *c*, which in marginal contour resembles the contour of *R. Calderi* when seen from below more nearly than any other specimens we have examined. The abactinal surface is low even for *R.*

pygmæus, and in no way differs from the general character of that species, to which we see little reason for hesitating to refer the example. Its preservation, however, is too bad to allow of a detailed description, and the test is also much obscured by matrix. It is altogether unfitted for illustration.

Dimensions.

	a. millim.	*b.* millim.	*c.* millim.	*d.* millim.	*e.* millim.	*f.* millim.	*g.* millim.
Length of the test . .	19	20	21·5	28	31	21	34
Breadth of the test . .	17	17	18·5	25	26·5	18	27
Height of the test . .	9	9	10	13·5	17	8	15

"*d*" and "*e*" are the two largest examples.
"*f*" is the depressed variety.
"*g*" is the elongate variety.

Localities. All in the Khirthar series:—

(i.) North by east of Petiáni, west of Kotri. Survey-number $\frac{G\,280}{92}$.

(ii.) North by east of Meting. Survey-number $\frac{G\,280}{96}$.

(iii.) Hills west of Unarpur. Survey-number $\frac{G\,280}{70}$.

(iv.) Three or four miles south-south-east of Meting, at the base of the scarp. Survey-number $\frac{G\,280}{111\,e}$.

(v.) Near Meting Railway-station. Survey-number $\frac{G\,280}{112}$.

(vi.) East of Júngsháhi. Survey number $\frac{G\,280}{117}$.

(vii.) Lowest scarp under Karothur Hill, eight miles east-north-east of Júngsháhi (at the base of the group). Survey-number $\frac{G\,280}{118}$.

(viii.) On the road, about four miles west of Kotri. Survey-number $\frac{G\,226}{147}$.

(ix.) Hills six miles north-west of Kotri. Survey-number $\frac{G\,226}{148}$.

(x.) Karra range, south of Trak. Survey-number $\frac{G\,302}{125}$.

Illustrations of the Species in Plate XXXIII.

Fig. 7. Abactinal view of the test: natural size.
8. Actinal view of the test: natural size.
9. Longitudinal profile of the same test: natural size.
10. The same test, seen from behind: natural size.
11. Abactinal view of the test of a large, widely expanded, and high form: natural size.
12. Longitudinal profile of the same test as fig. 11: natural size.
13. Abactinal view of the test of a large form: natural size.
14. Longitudinal profile of the same test as fig. 13: natural size.
15. Abactinal view of the test of a flat, depressed variety: natural size.
16. Longitudinal profile of the same test as fig. 15.

Family SPATANGIDÆ.

Subfamily SPATANGINÆ.

Genus MICRASTER, *Agassiz*, 1836.

Test more or less heart-shaped and inflated, with the anterior margin indented by the anteal sulcus.

Apical disk compact, subcentral or excentric in front.

The paired ambulacra petaloid, unequal, placed in shallow furrows. Poriferous zones equal; pores equal, pairs united by a conjugating furrow. The odd anterior ambulacrum placed in a sulcus, which is usually broad but not very deep; its poriferous zones are very narrow, with minute pores placed in widely spaced, oblique pairs.

Peristome bilabiate, very excentric in front.

Periproct oval, on the posterior extremity

A single fasciole, subanal, encircling the inferior margin of the posterior extremity.

Tubercles small, perforate and crenulate.

1. MICRASTER TUMIDUS, *Duncan & Sladen.* Plate XXXVII, Figs. 1-6.

Test of moderate size, tumid, roundly cordiform, vertically truncate posteriorly. Length rather greater than the breadth, or proportional as 1 : 0·95, the greatest breadth being slightly in front of the centre. Anteriorly the marginal contour is full and well-rounded, with the faintest suggestion of an impression corresponding with the position of the odd anterior ambulacrum, and a slight flattening midway on the anterolateral interradia. Behind the line of greatest breadth the test converges gradually and regularly, terminating with a rather sharp rounding on the posterior truncation. The greatest height is excentric posteriorly, and is equal to about three fourths of the length, the proportions of length to height being as 1 : 0·76. The test is high, full, and tumid. When viewed in longitudinal profile, the anterior slope is seen to dip at a comparatively slight angle, the anterior margin being very high, thick, and rounded. At the position of greatest height there is a gentle convex curve, and the posterior slope is much more rapid, as well as more convex, than the anterior. The posterior truncation is vertical, and is well rounded beneath on to the actinal surface. Seen in transverse profile, the great tumidity of the sides of the test is specially remarkable. The actinal surface is convex, the resting-plane being along the median line of the plastron, whence the test slopes downwards to the lateral margins. It is also rounded in front. There is a slight prominence on either side where the posterior truncation unites with the plastron. The periproct is very high, and placed at the top of the posterior extremity.

The apical system is small, slightly excentric in front, and consequently far in front of the general summit of the test; and its character is very compact. The four interradial (genital) plates are elongately hexagonal in shape and subequal in size, all touching one another equally. Three only are perforated by the genital foramina, which are large, circular, and occupy the greater portion of the plate. The fourth, or unpunctured, plate is the madreporite, and is perhaps a shade smaller than the other three, no extra development of this plate centrally taking place. The madreporiform body is small, compact, slightly convex, and confined to a limited oval area in the median portion of the plate. The ocular plates are comparatively large and subpentagonal in shape, and the posterior part of the plate forms a depressed cavity, within which the ocular pore is situated. The plates corresponding to the three anterior ambulacra each fill the angle between two of the facets of neighbouring genital plates. The two posterior ocular plates are juxtaposed; the right-hand plate is somewhat larger than its companion, and touches both of the posterior genital plates, the left posterior ocular plate filling in the angle formed by the sides of the left posterior genital plate and the right posterior ocular plate.

The ambulacra are short, broad, and petaloid, situated in broad but shallow depressions of the test, which thin out gradually at the distal extremity. The odd anterior ambulacrum is narrower than the paired petals, and is situated in a shallower groove, the depression being scarcely perceptible at the ambitus. After the petal has attained its normal width, at a short distance from the apical disk, the poriferous zones run parallel, and do not diverge apart. The pores are round, equal, and the pairs are placed oblique, each in a very faint depression. There are 14 or 15 pairs in each zone, extending to the ambitus, and the outermost three or four pairs are very widely spaced, and much smaller than the others. The interporiferous area is nearly twice the width of the same region in the paired petals, and its surface is covered with small, uniform, miliary granules.

The lateral or paired petals are subequal, the anterior pair being a shade longer than the posterior pair. The petals proceed direct from the apex outwards, and have no flexure; the anterior pair are widely divergent, the enclosed angle being about 140°. The poriferous zones increase in breadth gradually as they proceed from the apical extremity until past the middle of the petal, and then contract again slightly towards the distal extremity, which is rather remote from the margin. The interporiferous area is straight and nearly uniformly broad, excepting the normal constriction at the apical extremity; also a slight contraction at the distal extremity, which is remarkable. The surface of the area is smooth and devoid of granules. The poriferous zone is wider at its broadest part than the interporiferous area. The pores are wide apart, elongately pyriform, both inner and outer, the latter being slightly larger; and they are united by a shallow furrow, are slightly oblique in position, and are separated from adjacent pairs by narrow costæ, which are ornamented with a single line of six or seven small, uniform, miliary granules. The granules are best defined on the outer portion of the costal ridge, and tend to disappear before reaching the interporiferous area. Consequent on the gradual increase in the breadth of the poriferous zones in proceeding outwards, and the succeeding diminution towards the distal extremity, the outline of the ambulacra is markedly petaloid. Beyond the petaloid portion of the ambulacra there are about three pairs of small pores in continuation of each zone, widely spaced, the pores small, round and close together. The succeeding pores are simply microscopic. The extrapetalous portions of the poriferous zones diverge outwards towards the ambitus, and again converge as they approach the peristome.

The postero-lateral ambulacra are similar in every respect to the anterior pair above described, and, like them, proceed direct from the apex outwards. The curve of the anterior zone is perhaps slightly fuller near the apex than that of the companion posterior zone, but the difference is so slight that it is only perceptible in some specimens. The posterior petals enclose an angle of about 62°. The distal extremity of the petal is more remote from the margin than that of the anterior pair; and the extrapetalous portion of the ambulacra is of similar character to those above described. Three pairs of pores are well developed within the subanal fasciolar area. There are 23 to 26 pairs of pores in the poriferous zone of the antero-lateral petals, and usually one to three pairs less in the postero-lateral ambulacra.

The anterior interradia have a slightly tumid appearance, which is especially emphasized on the abactinal surface, the breadth and shallowness of the depressions in which the petals are placed causing the interradia to seem more prominent than they really are. In the lateral interradia the subcarinate character is less prominent, but is most highly developed in the odd posterior interradium, the narrow space between the postero-lateral petals forming a broad, low, well-rounded keel; and there is a slight tumidity in continuation of this along the median line of the area extending up to the periproct. The ornamentation consists of very small primary tubercles, punctured and crenulated, situated in a small scrobicule, and widely spaced, the intermediate space being filled with small, low, uniform, well-spaced miliary granules. On the abactinal area the ornamentation is so small that it is only seen under magnification. In the neighbourhood of the mouth it becomes larger, however; and on the plastron the tubercles are large and uniform, standing on large, prominent scrobicules, which are closely placed, and in parts imbricate or impinge on the neighbouring scrobicules.

The peristome is very excentric in front, is rather small and transversely oval in outline, and is surrounded by a slightly raised margin. The posterior lip is insignificant, very faintly produced, and is not prominent; but there is a rather prominent tumidity behind the lip, and a little remote from its margin, which merges gradually into the median tumidity of the plastron. The ambulacral regions in the neighbourhood of the peristome are slightly depressed.

The periproct is about equal in size to the mouth, is transversely oval, and situated at the extreme top of the posterior truncation. The general character of this area is on the whole tumid; but in the inferior part there may be a very faint tendency towards a median depression.

A broad, well-developed, subanal fasciole encircles the angle of the posterior margin, part being above and part below the rounded angle formed at the junction of the vertical posterior end and the actinal surface. The space enclosed is large and subreniform in outline, and the upper part of the fasciole dips down with a rather deep reentering curve, pointing downwards, in the median line. Three pairs of pores belonging to the posterior zone of the posterior petals are included within the fasciole, and mark its lateral boundaries.

The presence of a peripetalous fasciole is very doubtful. In none of the specimens is the delicate ornamentation of the test within the region of the petals sufficiently well preserved to enable this point to be settled. In one of the specimens which has some portions fairly well preserved an arrangement of granulation may be observed at the extremity of the antero-lateral petal, and extending for a short distance close along the posterior margin of the groove, which is rather suggestive of a fasciole. There is also a slight tumidity on one of the plates about midway on the anterior margin of the posterior petal, which might possibly indicate the line of direction taken by the supposed fasciole in crossing the postero-lateral interradium; but no actual band is discernible. The strip of granulation above referred to is, however, somewhat ill-defined, and wanting in compactness—a fact which, together with the inability of finding any trace of the fasciole-structure elsewhere, leads us to entertain very great doubts as to the presence of a second fasciole in the Spatangoid under notice.

Remarks. This very interesting form is readily distinguishable either from its congeners or any species with which we are acquainted. At first sight it strongly suggests the outline of *Toxaster*, but the structure is altogether different. The very doubtful presence of a peripetalous fasciole, which has been remarked upon above, is the only point upon which we hesitate in referring this Spatangoid to the genus *Micraster*. Until more perfectly preserved specimens are received, we do not feel justified in taking any other course.

Dimensions.

	millim.
Length of the test	36
Breadth of the test	34·5
Height of the test	27·5
Length of the antero-lateral petals	12·5
Length of the postero-lateral petals	11
Breadth of the paired petals	4·3
Breadth of the odd anterior petal	2·75
Transverse diameter of the peristome	4·5
Longitudinal diameter of the peristome	2·25

Locality. In the Khirthar series of strata: Baili, west of Tóng. Survey-number $\frac{G\ 304}{28}$.

Illustrations of the Species in Plate XXXVII.

Fig. 1. Abactinal view of the test: natural size.
2. Actinal view of the test: natural size.
3. Longitudinal profile of the test: natural size.
4. Odd anterior ambulacrum: magnified.
5. Portion of one of the petaloid ambulacra: magnified.
6. Apical disk: magnified.

Genus HEMIASTER, *Desor*, 1847.

(See *antea*, p. 78, Part ii.)

1. **Hemiaster apicalis**, *Duncan & Sladen.* Plate XXXIV, Figs. 1–7.

Test of large size, marginal contour irregularly suboval, widely expanded laterally, the greatest breadth lying across the posterior third. In front of this prominent lateral protuberance the test contracts rather rapidly, passing sharply round the subcarinate tumidity of the anterior interradial areas, and indented in front by a distinct but not very deep anteal sulcus. Behind the line of greatest breadth the outline of the test contracts rapidly, giving a somewhat pointed appearance posteriorly. The length of the test is slightly greater than the breadth, the proportions being as 1 : 0·923. The greatest height of the test lies a little behind the centre, and is proportional to the length as 0·56 : 1.

The apical disk, which is small, is excentric in front, the anterior portion of the median line being little more than one half of the posterior part. Seen in longitudinal profile, the anterior slope shows only a slight convexity, the anterior extremity being thick and tumid. The posterior slope of the test, after a short convexity along the saddle-backed keel of the posterior interradium, descends with an almost precipitous slope, the posterior margin being much less rounded than the anterior. Seen in transverse profile, the test, when viewed in front, has a high and somewhat conical appearance, the carinate portions of the paired interradia being distinctly visible. Owing to the anterior declivity of the test, the postero-lateral keels and the posterior wall of the antero-lateral petals are seen above the antero-lateral keels, and the prominent, well-rounded keel of the odd posterior interradium attains midway a still greater elevation. When seen from behind, the lateral portions of the dorsal profile have a fuller and more tumid appearance than when seen from the front, and the general contour of the profile is more convex, the median posterior keel being high and prominent. The position of the periproct is high, and appears to have been situated at the commencement of the inferior third of the height; but accurate observation on this point is impossible in the specimen under description, in consequence of fracture and imperfect preservation.

The apical disk is excentric in front and comparatively small. There are four generative pores, the posterior pair being very wide apart; and the posterior ocular plates are widely separated and pushed asunder, as it were, by a remarkably broad expansion of the central madreporiform body.

The odd anterior ambulacrum is in a well-defined, rather deep groove, which expands and becomes shallower as it approaches the margin, where it forms, however, a conspicuous indentation in the anterior contour. It is continued, although greatly diminished in depth, over the margin, and dies out just before reaching the peristome. The pairs of pores, which are situated in small oval cavities, are placed obliquely, and the pores of a pair are separated by a small tubercle. Near the apical extremity of the ambulacrum the pores are very small and closely placed, but as they proceed outward the size of the pores and the distance between adjacent pairs is greatly increased. Near to the fasciole the pores again become smaller, and outside its boundary are simply microscopic. The floor of the groove is covered with small low granules of two sizes, irregularly interspersed and rather widely spaced.

The antero-lateral petals are large, long, and in deep grooves. They have a very straight appearance, the breadth being comparatively uniform, and the expansion towards the outer extremity only slight. The groove does not terminate abruptly at this point, but contracts gradually, which gives to its outer end rather a pointed character. The divergence of the antero-lateral petals is great, the angle enclosed being about 120°. The poriferous zones are wide, the pores large and elongately pyriform, with the pores of a pair united by a shallow furrow, the intervening ridge being broad, and ornamented along its median line by a single row of small miliary granules. There are about 33 pairs of pores in each zone. The interporiferous area is very uniform in breadth, excepting at the apical extremity, where it narrows rapidly; its normal breadth is about equal to that of the poriferous zone at its widest part. The apical portion of the posterior zone is more precipitous than any other part, and the anterior zone is, on the whole, rather more precipitous than the companion zone, although both zones occupy entirely the lateral walls of the groove. The only ornamentation on the interporiferous area consists of a few very minute, very widely and irregularly placed miliary granules. The antero-lateral petals measure 25 millim. from the centre of the apical disk to their extremity, and are 6 millim. wide at their broadest part.

The postero-lateral ambulacra are four fifths of the length of the anterior petals, measuring 20 millim. long and 4·5 millim. broad. They are in deep grooves, similar to those of the anterior pair, and they do not expand greatly in width. The petals curve rather sharply inward at the apical extremity, and the posterior zone is more curved than the anterior zone, its contour being sigmoidal, in consequence of a rather rapid bend outward at the outer extremity, whilst the outline of the anterior zone is a simple curve. There are about 29 pairs of pores in each zone, and their character is similar to that of the anterior petals above described. The posterior are much less divergent than the anterior pair of petals, the angle they enclose being about 60°.

The anterior interradia have the appearance of forming a high tabular keel, in consequence of the deep ambulacral grooves and the gently rounded slope of the interradia to their margins. At the apical extremity this apparent carination is bevelled off to the level of the apical disk. Each of the plates of the interradial areas is slightly tumid, which imparts a rather knobby character to the test, the feature being most marked in the plates just above the ambitus. The lateral interradia are higher and rather more carinate in appearance at the apical extremity, although they are bevelled off in the neighbourhood of the disk in the same manner as the anterior areas. The odd posterior interradium is narrow, high, and prominently convex, forming a regularly rounded saddle-back, whether viewed transversely or longitudinally, the apical portion sloping down gently to the level of the apical disk. The posterior character of the odd interradium immediately above the periproct is much damaged. The margins of the test are tumid and well rounded on to the actinal surface, excepting perhaps posteriorly, where there is a tendency towards rostration. The plastron and the neighbouring portions of the test are destroyed.

The peristome is large, very excentric anteriorly, and measures 9·5 millim. in breadth (transverse diameter). It is well rounded at the sides, and there is no rim on the anterior margin. The posterior margin or lip is destroyed.

One fasciole only, which is peripetalous and well developed. It is broadest at the extremity of the antero-lateral petals, touching the groove at this point. It curves round and passes inward somewhat obliquely, and, diminishing gradually in thickness, is then continued for a very short distance parallel with the petal, and more than half the breadth of the groove remote from its margin; before it has reached midway along the petal it bends abruptly backwards, passing in an oblique line inwards towards the outer third of the postero-lateral petal. On attaining the commencement of the downward slope of the area along the margin of the petal the fasciole is again bent, and, following the outline of the petal, passes close to its posterior extremity, and thence mounts immediately the high posterior keel. In front the fasciole passes from the extremity of the antero-lateral petal in a straight line, directed forwards and inwards, to the summit of the adjacent tumid interradial plate, diminishing in width in its course. From this knob it passes in a straight line, still forwards and inwards, to the knob of the correspondent plate on the companion column, increasing temporarily in breadth midway. From the anterior knob the fasciole passes a little forwards, and crosses the anterior sulcus with a forward-bending curve at a very little distance from the ambitus.

The ornamentation of the test is remarkably handsome. It is smaller towards the posterior portion of the test and within the fasciole, and increases in size at the margins and on the actinal surface. It is also rather larger along the margins of the ambulacral grooves than on the other portions of the interradia circumscribed by the fasciole. Just above the ambitus in the anterior interradia, where the ornamentation is well developed, it consists of large primary tubercles, with a small perforate mamelon on a low and coarsely crenulated boss, standing on a large, circular, scale-like scrobicule, the aboral half of which is prominent, whilst the adoral merges imperceptibly into the substance of the test. A single row of small, well-spaced, and equal-sized miliaries surrounds the scrobicule; and additional ones may be present on the actinal surface, where the tubercles and their scrobicules are larger and more widely spaced.

Remarks. This species has much resemblance in form to some of the species of the genus *Linthia*; but it is clearly a *Hemiaster*, in possessing only a peripetalous fasciole, portions of the test which would be traversed by the latero-subanal fasciole, if present, being well preserved.

Dimensions. Length of the test 65 millim., breadth 60 millim., height 37 millim. (or probably somewhat greater).

Locality. In the Khirthar series of strata: Gorge of the Báran river, north-east of Búla Khán's Thána. Survey-number $\frac{G\ 280}{71}$.

Illustrations of the Species in Plate XXXIV.

Fig. 1. Abactinal view of the test: natural size.
2. Longitudinal profile of the test: natural size.
3. Transverse profile, seen from the front: natural size.
4. Apical disk: magnified.
5. Portion of the odd anterior ambulacrum: magnified.
6. Portion of one of the antero-lateral petals: magnified.
7. Ornamentation of the test near the ambitus in one of the anterior interradia: magnified.

2. **Hemiaster nobilis**, *Duncan & Sladen.* Plate XXXIV, Figs. 8–11.

Test of large size; marginal contour ovally subcordiform, somewhat flattened in front, and very faintly incurved in the region of the odd anterior ambulacrum. The line of greatest breadth lies across the centre of the test, and is proportional to the length as 0·93 : 1. Behind this line the contour contracts gradually, its outline forming a subparabolic curve.

The apical disk is excentric posteriorly, and the greatest height of the test lies a short distance behind this. The condition of the specimen unfortunately does not admit of these proportions being determined accurately, but, as far as judgment can be drawn from the example in its present state, the height appears to have been about three fifths of the length. Seen in longitudinal profile, the keel of the odd posterior interradium does not stand at a higher level than the keels of the lateral interradia, and the posterior slope of the test at a short distance from the apical disk slopes down rather abruptly, with a steep incline to the posterior margin. The anterior slope is much more gradual, and, after a slight curve near the apex, is straight until it reaches the very thick and tumid anterior margin, on which some gibbous protuberances are noticeable. The posterior margin was probably thick, but much less than the anterior margin, and was probably rounded. Seen in transverse profile, the lateral slopes of the dorsal surface are much less inclined than in *H. apicalis*, and the lateral margins are also very much thicker.

The odd anterior ambulacrum is in a very wide groove, rather deep in the middle portion of its course, but becoming shallower as it approaches the margin, whilst at the ambitus its presence is indicated only by the faintest incurving of the outline, and is continued in a similar indefinite manner towards the peristome. The pairs of pores, which are situated in small and rather deep oval cavities, are placed obliquely, and the pores of a pair are separated by a rather elongate and pointed granule or tubercle. Near the apex the pairs of pores are very closely placed, but become more widely spaced as they proceed outward, and become single (or apparently so), very widely spaced, and almost microscopic in size beyond the fasciole. The floor of the groove is covered with a minute but rather well-spaced granulation.

The antero-lateral petals are large, long, and in wide deep grooves, of almost uniform breadth, except near the apex, and with their outer extremity well rounded.

Close to the apex the petals are narrow, and appear to proceed originally almost at right angles to the longitudinal axis of the test. They speedily take a rapid curve forward, and their course is then almost straight towards the margin, the apparent distance at which they terminate therefrom being comparatively small. The angle enclosed by the anterior pair of petals is about 94°. The poriferous zones are very wide in the median part of the petal, but very narrow and small near the apex, where they occupy the vertical half of the groove, and they also diminish in size towards the outer extremity of the zone. The inner pores are oval, and the outer larger and pyriform, the pairs being united by a broad furrow, and adjacent pairs separated by well-defined and keel-like costæ, on which are one or two somewhat irregular series of small granules. The interporiferous area is nearly uniform in breadth, except at the apex, and is narrower than the poriferous zone at its widest part. The ornamentation consists of very minute, uniform, and widely-spaced granules. The antero-lateral petals measure 28 millim. from the apical disk to their extremity (without calculating for the curve at the apex), and are 6·5 millim. wide at their broadest part.

The postero-lateral ambulacra are three fourths of the length of the anterior petals, measuring 21 millim. long and 5·5 millim. broad. They are in deep grooves, similar to those of the anterior petals, and have a very uniformly broad character, the contraction at the apex being comparatively slight and rapid, and the outer extremity being well rounded. Their course from the apex towards the margin is almost straight, and the angle they enclose is about 62°. The keel of the anterior interradia is not remarkably high, but is emphasized by the depth of the grooves of the antero-lateral petal and the anterior odd ambulacrum. These interradia are very thick and tumid at the margin, and individual plates are more or less tumidly protuberant. The lateral interradia are not higher than the anterior interradia, and have the appearance of being less carinate, although there is a rather prominent protuberance a short distance from the apex, where the general surface of the interradium is flattened and slightly concavely depressed. The odd posterior interradium is narrow and prominently carinate locally. It is flattened close to the apex, then occurs the protuberance, and the general area is again flattened as its breadth expands outwards. Behind the protuberance the test slopes downward with a steep incline to the posterior margin.

The periproct appears to have been situated on the upper part of the rounding of the posterior margin, but only a trace of its existence can be made out, in consequence of damage to the whole of the actinal portion of the test.

One fasciole only, which is peripetalous and embraces a large portion of the surface. Passing near to the extremity of the antero-lateral petals, it sweeps with a well-rounded curve which runs parallel to the inner margin of the groove, and extends nearly midway between the extremity and the apex before it is curved backward, to cross the lateral interradial area. Its course towards the posterior petals is diagonal, and still directed somewhat inward. At a considerable distance from the margin of the groove of the posterior petal it is deflected outward, and commences the well-rounded sweep which passes near to the outer extremity of the posterior petal, and is then directed inward and upward to cross the odd posterior interradium to join with the corresponding part of the fasciolar band from the other side. In front the fasciole is well rounded at the extremity of the antero-lateral petals, and is directed inwards, crossing the keel of the anterior interradia with a slightly incurved course, and when near to the wide groove of the odd anterior ambulacrum it curves rather sharply forwards, and is then bent rather abruptly at right angles to descend the groove, which it crosses at the upper portion, or commencement, of the marginal tumidity; the fasciole consequently appears well remote from the ambitus, and is especially so in the median region of the anterior interradia.

The ornamentation on the abactinal surface of the test is generally small, but becomes larger in the lateral regions and in front, whilst at the ambitus in front and on the actinal surface there it is remarkably large and well defined. The primary tubercles at this place have a small perforate mamelon on a comparatively large, tumid, and button-shaped crenulate boss, standing on a circular disk-like scrobicule. The scrobicules are separated by a single ring of minute miliary granules, which is often incomplete. In the plates having tumid prominences the ornamentation is usually smaller and more crowded in the centre of the raised portion, the size increasing gradually outward therefrom.

Remarks. This large and handsome form is a worthy congener of the species above described. It is readily distinguished from *H. apicalis* by the different form of the test, by the comparatively low and sloping posterior region, by the size, shape, and divergence of the ambulacral petals, by the different course of the fasciole, which is also more remote from the margin, and by the larger and more widely-spaced tuberculation on the anterior part of the test.

Dimensions. Length of the test 62 millim., breadth 58 millim., height 37 millim., approximately (probably somewhat higher).

Locality. In the Khirthar series of strata. Hilly ground, south-east of Trak Hill. Survey-number $\frac{G\,302}{122}$.

Illustrations of the Species in Plate XXXIV.

Fig. 8. Abactinal view of the test: natural size.
9. Longitudinal profile of the test: natural size.
10. Portion of the odd anterior ambulacrum: magnified.
11. Portion of one of the antero-lateral petals: magnified.

3. Hemiaster carinatus, *Duncan & Sladen.* Plate XXXIV, Figs. 12–14.

There is a fragment of a *Hemiaster* in the collection which is sufficiently preserved to show characters of a very remarkable nature, and on this account we have ventured to name it, although the condition of the fossil unfortunately does not admit of a complete diagnosis of the species being given.

The test was of medium size, probably subrotund and very broad. Apical disk subcentral, with the test apparently sloping nearly uniformly therefrom on all sides. The odd anterior ambulacrum is situated in a wide deep groove. The antero-lateral petals in wide and somewhat deeper grooves, whose size and character is emphasized by the remarkable carination of the anterior interradia,—a sharply prominent median keel being developed, from which the test slopes steeply down to the groove on either side; whilst the individual plates of the interradium are also subtubercularly prominent along this line and add considerably to the remarkable facies of the test. The lateral interradia show the same feature of carination along their median line, but to a less degree. The odd posterior interradium is decidedly convex and carinate, and its slopes form a convex curve. The carinations of the interradia die out as they approach the apex, and the apical disk is consequently only very slightly depressed below the general level.

The course of the antero-lateral petals is almost straight from the apex towards the margin, and the outer extremity of the groove is very shallow and apparently ill-defined. The divergence of this pair of petals is very wide, the angle subtended being about 116°–120°. The postero-lateral petals are comparatively long, measuring about 14 millim., whilst the anterior pair are about 17 millim. in length; the general characters in both being similar.

In the odd anterior ambulacrum the obliquely placed pairs of pores are rather wide apart, the inner pore being somewhat comma-shaped, the outer one larger, and separated from its companion by a large and partly overhanging lip-like tubercle or granule; the whole floor of the groove is covered with small crowded granules. In the antero-lateral petals both the inner and the outer pores are long and slit-like and rather wide apart; the pairs are separated by a very broad space or band, which does not develop a ridge-like keel, but bears usually two rows of small uniform granules, the suture of the plates being visible between the two series, and there is a faint trace of a feebly raised rim encircling the pore-slit. Near to the apex the inner series of pores are almost aborted.

The structure of the apical disk is interesting. The anterior pair and the posterior pair of generative pores are equidistantly placed, and the posterior pair of ocular pores are placed directly beneath the latter, being also at an equal distance apart, and they are separated by an extension of the median madreporiform body; there is thus a regular line of three pores on either side of the median line. The anterior pair of ocular pores are placed external to the anterior generative pores, with which they form a transverse line of four pores. The odd anterior ocular pore is slightly in front of the anterior generative pores.

Traces of a single narrow peripetalous fasciole are present. There was no lateral fasciole.

The ornamentation of the test is comparatively large, isolated, and remarkably well defined.

Dimensions. We are unfortunately unable to give the usual measurements of the test. The following dimensions may serve as a guide. From the centre of the apical disk to the margin, along the median line of the anterior interradium, about 25 millim.; from the centre of the apical disk to the margin, along the median line of the postero-lateral interradium, about 30 millim.

Locality. In the Khirthar series of strata. On the road about four miles west of Kotri. Survey-number $\frac{G\ 226}{147}$.

Illustrations of the Species in Plate XXXIV.

Fig. 12. Abactinal view of the test: natural size.
13. Portion of the odd anterior ambulacrum: magnified.
14. Portion of one of the antero-lateral petals: magnified.

4. HEMIASTER DIGONUS, *d'Archiac*, sp. Plate XXXV, Figs. 4–9.

This small and well-characterized form is very numerous in the white chalky saline limestone, on the Báran river, near Kotri. Although the collection contains a great number of specimens the largest does not exceed 22 millim. in length; and owing either to considerable decay prior to fossilization, or more probably to some chemical action induced by the nature of the deposit, comparatively little structure is preserved, notwithstanding that the specimens at first sight appear to come well from the matrix and would be taken for well-preserved examples.

We are fortunately able to add to the description given by MM. d'Archiac and Haime (*op. cit.* p. 220) a notice of the peripetalous fasciole, which we have succeeded in tracing in several examples completely, and more or less so in the majority of specimens before us. It is, however, very indistinct and difficult to make out. Its course is very rotund, devoid of any reentering sinuosities, and it passes at a low level anteriorly across the anterior sulcus. Its relation to the petaloid ambulacra is shown in fig. 7.

In general form this species presents considerable resemblance to that of *Schizaster thebensis*, de Loriol; the resemblance, however, being only so far as the character of the outline is concerned.

In examining a large series of specimens, it seems to us that the form of the test is generally more inflated at the sides and higher in the odd posterior interradium than in the figures given of this species in the 'Animaux fossiles.' There is, however, a considerable amount of variation in this. Considerable variation also exists in the degree of the posterior excentricity of the apical disk and likewise in the width of the anterior groove. We have drawn in fig. 8 an example in which the groove of the odd anterior ambulacrum is remarkably wide and trough-like, the inner portion of the anterior interradia being reduced to high angular keels. Fig. 9 shows a small example in which the apical disk is pushed backward to an extreme degree, the small posterior petals appearing, when seen from above, to be situated on the sloping curve of the posterior extremity.

Localities. In the Khirthar series:—

i. Bolári Bridge, on the Báran rivers, south-west of Kotri. Survey-number $\frac{G\ 280}{85}$.

ii. Three or four miles south-south-east of Meting. Survey-number $\frac{G\ 280}{1115}$. (A single badly preserved specimen.)

iii. Twelve miles east of Kandaira. Survey-number $\frac{G\,2/6}{149}$. (Two specimens so much crushed and obscured as to be almost unrecognizable. Possibly they may represent a variety.)

Illustrations of the Species in Plate XXXV.

Fig. 4. Abactinal view of the test: natural size.
5. Actinal view of the test: natural size.
6. Longitudinal profile of the test: natural size.
7. A portion of the abactinal surface, to show the apical disk, the ambulacral petals, and the fasciole: magnified.
8. Abactinal view of a test with very broad anterior groove: natural size.
9. Abactinal view of a test with apical disk very excentric posteriorly: natural size.

5. **Hemiaster**, sp Plate XXXV, Figs. 25 & 26.

There is in the collection a single specimen of a small subglobular test which we refer to *Hemiaster*; but the fossil is so badly preserved and obscured with matrix that even the generic determination is doubtful. It is certainly distinct from any of the other Indian species, and on this account we have included this very unsatisfactory specimen on Plate XXXV. The marginal contour is suboval or subglobular, with the anterior margin moderately indented by the anteal sulcus, and the lateral portions of the test very tumid; the posterior extremity is roundly truncate, and when seen in longitudinal profile is high and almost vertical, the periproct being situated near the summit of the extremity. The lateral portions of the test are high and tumid, both laterally and dorsally. The odd posterior interradium is likewise tumid in the latter region. Traces of a peripetalous fasciole are discernible, but the test is too much destroyed by weather-action for any statement respecting the presence or absence of other fascioles to be made. No other details of structure or form can be observed.

Dimensions. Length of the test 24 millim., breadth 22·5 millim., height 17 millim.

Locality. In the Khirthar series. Twenty-four miles west of Kotri (entering the Hills on the road to Búla Khán's Thána). Survey-number $\frac{G\,280}{72}$.

Illustrations of the Species in Plate XXXV.

Fig. 25. Abactinal view of the test: natural size.
26. Actinal view of the test: natural size.

6. **Hemiaster**, sp.

There is another test of a small Echinoid in a very bad state of preservation which we refer to this genus. The marginal contour has some resemblance to that of the preceding specimen, but the form is abactinally much more depressed. In general outline it resembles to a certain extent *H. digonus*, but is devoid of the deep anteal sulcus of that species, and is much more tumid on the lateral portions of the dorsal surface. Faint indications of a peripetalous fasciole may be seen; and there are no traces of any lateral fasciole present. The condition of the specimen is such that a description is impossible; and it is quite unfitted for illustration.

Length of the test 21·5 millim., breadth 21 millim., height about 14·5 millim.

Locality. In the Khirthar series. Karra range, south of Trak. Survey-number $\frac{\text{G } 302}{125}$.

7. **Hemiaster**, sp.

There is a greatly broken fragment from the white chalky limestone of the Báran river of a fine and handsome species of *Hemiaster*. Unfortunately only a portion of the test remains, and the greater part even of this is either broken or obscured by matrix. We have succeeded in exposing a part of the anterior region, which shows the outer part of the odd anterior and right anterior lateral petals. This and a portion of the lateral region of the test are all that are available for observation, and the condition is such that no intelligible drawing can be given. Judging from what can be seen of the marginal contour, of the characters of the anterior interradia, and of the course of the peripetalous fasciole, the fragment presents the closest affinity to *Hemiaster apicalis*, described on a preceding page. The anterior pair of petals, however, have the extremity of the groove more fully rounded, the margins appear to be straighter and more parallel, and their angle of divergence is smaller than in that species, the character of the petals as a whole being much nearer to *H. nobilis*. Notwithstanding this we are very strongly inclined to regard the form in question as a young or medium-sized example of *H. apicalis*; but as doubt obviously exists from the very unsatisfactory and indeterminable nature of the fragment, and as any observation upon the character of the apical region of the test and of the odd posterior interradium is impossible, we refrain from ranking it definitely with that species, until a further supply of material is available for study.

The test, of which the present fossil is a fragment, was originally about 49 millim. in length.

Locality. In the Khirthar series of strata. Bolári Bridge, on the Báran rivers, south-west of Kotri. Survey-number $\frac{\text{G } 280}{85}$.

Genus BRISSOPSIS, *Agassiz*, 1847.

Test oval or oblong, subcordiform, having the anterior margin indented by the anteal sulcus, more or less inflated at the margins and on the abactinal surface; actinal area frequently more or less convex.

Apical disk compact, subcentral or excentric in front.

Paired ambulacra petaloid, subequal, in shallow furrows, more or less curved. The anterior pair widely divergent, the posterior pair more closely approximated. The two lateral petals on either side of the test usually forming two more or less definite arcs which touch at their convexity at the apical disk. Poriferous zones equal, very wide; pores equal or subequal. The anterior zone of the anterior petals and posterior zone of the posterior petals having some pores atrophied at the apical extremity. The odd anterior ambulacrum is placed in a shallow sulcus; its poriferous zones are composed of simple minute pairs of pores, widely spaced.

Peristome bilabiate, excentric in front.

Periproct oval, on the posterior extremity.

Two fascioles: a peripetalous one, more or less sinuous, which surrounds the petals and approaches the anterior margin; a subanal fasciole, which is complete.

Tubercles perforate and crenulate, small on the upper surface; larger and more widely spaced below the ambitus, especially in the anterior region and on the actinal surface.

1. BRISSOPSIS SUFFLATUS, *Duncan & Sladen*. Plate XXXV, Figs. 17–24.

Test of medium size. Marginal contour elongate, elliptical, greatest breadth across the middle, converging equally anteriorly and posteriorly, narrow in front, with the anterior margin widely and rather deeply indented by the anterior groove, truncate posteriorly. The greatest breadth is rather less than three fourths of the length, or in the proportion of 0·73 : 1. The dorsal surface is subdepressed, very tumid in the interradia, and the margins are thick and tumid. When seen in longitudinal profile the dorsal surface has a remarkable appearance, presenting three convex undulations, which represent the outline of the interradia—the median undulation formed by the lateral interradia being rather higher than the anterior undulation, and the posterior undulation being a little higher than the lateral (median) undulation. The greatest height of the test consequently lies near the posterior extremity of the test, and when measured from the culminating point of the actinal plastron to the highest part of the odd posterior interradial convexity, is less than half the length, or in the proportion of 0·45 : 1. The actinal surface is rather flatly convex, being well rounded to the margin, and is characterized by the presence of a sharp angular keel or ridge, which extends along the median longitudinal line of the test from the peristome to the culminating point of the plastron, the height increasing as it approaches this point; the test then sharply diminishes with a precipitous slope, which terminates abruptly at the posterior truncation.

Apical disk excentric in front. The posterior pair of generative pores rather wider apart than the anterior pair; and the posterior pair of ocular plates separated by the prolongation of the central madreporiform body. The groove of the odd anterior ambulacrum is wide but very shallow, and appears to mount the convexity of the test which intervenes between the apical disk and the anterior margin; it is deepest just above the ambitus, where the indentation of the anterior margin is well defined, but its continuation on the actinal surface towards the peristome becomes very faint. The poriferous zones are straight and rather near together, the pores being very minute and sunken in small cavities, which simulate a uniserial line of single pores, placed wide apart.

The antero-lateral petals are situated in wide and rather deep cavities; they are widely divergent, subtending an angle of about 120°, and have a slightly arched appearance, in consequence of the curvature of the anterior zone, which is bent convexly forwards, whilst the posterior zone is comparatively straight. The posterior petals are rather longer than the anterior pair, they are slightly curved, with concavity forwards and outwards, and the inner margins of the two petals are very near together for quite half their length. The odd posterior interradial space is a narrow wedge-shaped strip, which presents scarcely any tumidity on the inner part of the area; the character developing gradually, however, and culminating in the region external to the petals. The cavities in which the posterior petals are lodged are scarcely so deep as those of the anterior petals; and the curvature of the respective petals gives a decided suggestion of a semicircular arch formed by the union of the anterior and posterior lateral petals.

The poriferous zones of the petaloid ambulacra have their pores large, oval or comma-shaped, with the pores of a pair rather wide apart and united by an indistinct groove; a rather broad strip occurs between neighbouring pairs, but no keel is formed, though its position is occupied by a single row of small uniform granules borne on the aboral margin of the ambulacral plate. The interporiferous area is extremely narrow, its width being less than the distance which separates the pores of a pair. The four or five pairs of pores near the apical extremity of the anterior zone of the antero-lateral petals, and the seven or eight similar pairs of the posterior zone of the postero-lateral petals are much aborted and reduced in size.

The posterior ambulacral areas on the actinal surface are very wide and naked, and they bound the prominently keeled actinal plastron.

The peristome is large and excentric in front, its position being about equidistant from the anterior and lateral margins of the test. The anterior margin of the aperture is semicircular, and the posterior lip is prominent and more or less keeled.

The periproct is very large, subcircular in form, and situated at the summit of the posterior truncated extremity. The inferior portion of this extremity is slightly depressed beneath the periproct, forming a faint concavity which gives emphasis to the rather abrupt separation from the subanal plastron, the plane of which stands at an angle between the anal plastron on the one hand and the posterior extremity on the other. The ornamentation of the concavity beneath the periproct is devoid of any large tubercles. The ornamentation of the subanal plastron is very small on the side adjacent to this concave area, and increases gradually in size as it recedes from it and approaches the actinal plastron.

Two fascioles are present on the test, the peripetalous and the subanal. The peripetalous fasciole is very sinuous and fiddle-shaped; it crosses the anteal sulcus with a wide sweep just above the rounding of the margin, traverses the central portion of the anterior interradia obliquely, and on the posterior column of this area is sharply bent inwards nearly at a right angle, but is almost immediately again abruptly deflected, and thence sweeps round the antero-lateral petal with a well-rounded curve; the course then curves with a re-entering sweep across the lateral interradia and runs nearly parallel with the median longitudinal line of the test until it is abruptly rounded at the extremity of the postero-lateral petal, and thence proceeds at right angles to its previous course across the odd posterior interradium.

The subanal fasciole is large, reniform, and bounds the subanal plastron; its incurved margin forms the line of separation between the vertical posterior extremity and the inclined subanal plastron, whilst the adoral or convex margin separates the subanal and the actinal plastron, the deepest part of the curve passing through the culminating point or peak of the actinal longitudinal ridge. Three or four pairs of ambulacral pores are included within the fasciole on either side of the subanal plastron.

The ornamentation of the test consists of large primary tubercles having a small perforate mamelon on a large, button-shaped, and granularly crenulated boss, placed on a circular disk-like scrobicule; and with a few minute and uniform granules irregularly dispersed between neighbouring scrobicules. The primary tubercles are very small on the abactinal surface generally, but are large on the actinal surface, especially on the anterior part of the test and at the margin. In these regions it not unfrequently happens that one edge of the scrobicular disk is raised, forming a small semicircular embankment, the remaining portion of the disk being apparently aborted.

Remarks. The nearest ally of this species is probably *Brissopsis Jimenoi,* Cotteau, from the Miocene of Cuba. The Indian species, however, is readily distinguished by its more elongate and more depressed form, by its anteriorly excentric apical disk, by the different form of the peripetalous fasciole, and by the prominent and peak-like culminating point of the actinal plastron.

The form appears to be very constant, and young examples 18 millim. in length have all the characters of the adult stage. The test, however, is relatively narrower and more elongate in small specimens, and the greatest breadth is near the anterior extremity, and the posterior portion of the test is more contracted than in the larger specimens. The latter embryonic character is most marked in the smallest example we have, which measures 12 millim. in length.

Dimensions.

	a.	*b.*	*c.*	*d.*
	millim.	millim.	millim.	millim.
Length of the test	40	26·5	18·5	12
Breadth of the test	29·5	20	13	9·25
Height of the test	18	13	8·5	5·75

Locality. In the Khirthar series of strata. Lowest scarp under Karothur hill, eight miles east-north-east of Júngsháhi (at the base of the group). Survey-number $\frac{G\,280}{118}$.

Illustrations of the Species in Plate XXXV.

Fig. 17. Abactinal view of the test: natural size.
18. Actinal view of the test: natural size.

Fig. 19. Longitudinal profile of the test: natural size.
20. A portion of the abactinal surface, to show the apical disk and the ambulacral petals: magnified.
21. Abactinal view of the test of a young example: natural size.
22. Actinal view of the same test: natural size.
23. Longitudinal profile of the same: natural size.
24. A portion of the abactinal surface to show the apical disk and the ambulacral petals of the young specimen: magnified.

Genus METALIA, *Gray*, 1855.

Test oval, with the margin slightly indented anteriorly by the anteal sulcus, and more or less truncate posteriorly. Abactinal surface arched direct from the margin, which is thin and well rounded, the actinal surface being more or less flat.

Apical disk compact, excentric in front.

Paired ambulacra petaloid, usually subequal, in very shallow grooves, which are straight from the apex towards the margin. The anterior pair very widely divergent, nearly horizontal, the posterior pair much less so. Poriferous zones wide, equal; pores equal, wide apart, distinctly conjugate; the immediate apical portion of the zones somewhat atrophied,—the anterior zones of the anterior petals and the posterior zones of the posterior petals more than the companion zones. The odd anterior ambulacrum in a very shallow sulcus; its poriferous zones composed of minute pairs of pores, obliquely placed and widely spaced.

Peristome bilabiate, excentric in front.

Periproct subrotund, on the posterior extremity.

Two fascioles—peripetalous and subanal. The peripetalous slightly sinuous, and extending to the anterior margin; the interradia within its boundary often with some large and widely spaced tubercles. The subanal fasciole is large, subreniform, and complete.

Tubercles very small and crowded on the abactinal surface, large and well-spaced on the actinal.

1. **Metalia Sowerbyi**, *d'Archiac*, sp. Plate XXXV, Figs. 10–16.

Brissopsis Sowerbyi, *d'Archiac* (1850), *Hist. des progrès de la Géol.* t. iii. p. 251.
Brissopsis? Sowerbyi, *d'Archiac & Haime* (1853), *Descrip. An. foss. de l'Inde*, p. 220, pl. xv, figs. 7*a*, *b*.

The following is the diagnosis of this species given by MM. d'Archiac and Haime:—

Body slightly elongate, expanded laterally in the median region, rather high, especially in front; apex situated nearly at the anterior third of the major diameter; four generative pores closely approximated, the posterior the largest; the four ocular pores very distinct; the odd anterior ambulacrum forming an expanded groove, tolerably pronounced and bounded on each side by a rather thick subgibbous carination. The petaloid ambulacra are grooved, straight, narrow, of medium size; the lateral nearly as long as the posterior; the pores large, rather closely placed; poriferous zones costulate, a little broader in the lateral than in the posterior petals, and with their interporiferous area narrower; some small isolated tubercles on the margins of the ambulacra; the peripetalous fasciole subpentagonal, scarcely sinuous, touching the extremity of the petals. Lateral interambulacral areas a little broader than the anterior and the posterior, all a little prominent in the neighbourhood of the summit. Anus marginal; periproct rounded? Inferior disk almost flat, very feebly inflated in front of the anus; mouth situated at the anterior two fifths of the major axis; peristome transversely elongate and strongly labiate, surrounded with a distinct floscelle of ambulacral pores, simple for the most part. On the abactinal surface some large granules may be seen, and those on the actinal interambulacral areas are still larger. The largest individual observed was 3½ centimetres in length, a little more than 3 centimetres broad, and a little less than 2 centimetres high. A flatter variety was only 1 centimetre in height and 2½ centimetres long.

To this description we may add that a large, complete, and well-developed subanal fasciole is present, of wide extent, and circumscribing a subreniform area on the rounded margin, which joins the actinal surface and the posterior extremity. The course of this fasciole beneath the periproct is deeply reentering, and the opposite part of the fasciole where it passes the hindermost part of the actinal plastron is more or less incurved, which causes the fasciole to approach somewhat the outline of the figure **8**. About five or six pairs of minute pores are present on either side of the subanal plastron within the fasciole. The course of the peripetalous fasciole is not correctly shown in d'Archiac and Haime's drawing (*op. cit.* plate xv, fig. 7); a slight but abrupt bend being present both in the lateral and the anterior interradia (although one or both of these may frequently be absent on either side), and the fasciole does not pass forwards over the margin, as the figure would lead one to suppose. The larger primary tubercles which are present on the interradia within the peripetalous fasciole are not regularly disposed along the margins of the grooves of the petaloid ambulacra as represented in the figure and the description; they have a much more distributed appearance, and sometimes two or three are together in irregular horizontal series. On either side of the groove of the odd anterior ambulacrum each plate has a wedge-shaped group of larger tubercles, the largest being nearest to the groove, and those external to them becoming gradually smaller. On the actinal and anal plastrons the ornamentation diminishes in size towards the slightly prominent culminating point at the posterior extremity of the actinal plastron; and the tubercles are arranged in lines, more or less distinctly traceable, which radiate from this point.

There are a number of young specimens in the collection, which accord in all particulars with the adult form; the smallest, which measures 17 millim. in length, is figured in Plate XXXV.

Remarks. The generic diagnosis given above sufficiently indicates the grounds on which we have removed this species from the genus *Brissopsis*, in which it was originally placed by d'Archiac and Haime. The shape of the test, with the upper surface arching direct from the margin (which, though rounded, is thin and not tumid), together with the flat actinal surface, present a facies widely different from that of *Brissopsis*. The character of the ambulacral petals is different; and the form of the peripetalous fasciole appears to be more simple. The drawings of the species given in the 'Animaux fossiles' are not good, and appear to have misled Desor to place the form in the genus *Prenaster*, an error which has been subsequently repeated by de Loriol.

Variations. In examining a large number of specimens from different localities a considerable amount of variation may be observed. This chiefly affects the form of the test only; and although the modified characters may possibly have, to a certain extent, a local significance, we do not consider that they demand any further recognition than a notice of their occurrence, as intermediate connecting-links with a central type-form may readily be traced. The extremes of this range of variations may be said to be:—(1) a form in which the breadth is greater and the height is less in proportion to the length of the test than in the central type—the result being a comparatively depressed and more rotundly oval form; and (2) a form in which these proportions are reversed, the breadth being less and the height being greater in relation to the length, the general aspect of the test being consequently more elongate, with the abactinal surface higher and more arched or subconoid in character when seen in profile. The wider and more rotund variety is usually of larger size, and appears to be abundant at the collecting-stations designated with the Survey-numbers $\frac{G\,280}{118}$ and $\frac{G\,280}{111\,c}$, whilst the more elongate and higher form seems to be best represented at station $\frac{G\,280}{98}$.

Dimensions.

	a. $\frac{G\,280}{111c}$.	b. $\frac{G\,280}{118}$.	c. $\frac{G\,280}{111c}$.	d. $\frac{G\,280}{118}$.	e. $\frac{G\,280}{111c}$.	f. $\frac{G\,280}{96}$.	g. $\frac{G\,280}{98}$.
	millim.	millim.	millim.	millim.	millim.	millim.	millim.
Length of the test .	34	34	32·5	32·5	30	24·5	17
Breadth of the test .	31·5	30·5	30·5	28·5	26	22	14
Height of the test .	19·5	15·5	15	15	17	14	8·75

Localities. In the Khirthar series of strata:—

i. Lowest scarp under Karothur hill, eight miles east-north-east of Júngsháhi (at the base of the group). Survey-number $\frac{G\,280}{118}$.

ii. East of Júngsháhi. Survey-number $\frac{G\,280}{117}$.

iii. Three or four miles south-south-east of Meting (at base of the scarp). Survey-number $\frac{G\,280}{111c}$.

iv. Five miles east-fifteen-north of Ghatana Trig Station, near Jhímpír. Survey-number $\frac{G\,280}{106}$.

v. Aongar hill scarp, east of Meting Railway-Station. Survey-number $\frac{G\,280}{99}$.

vi. Limestone ridge, three or four miles south of Band Vero. Survey-number $\frac{G\,280}{98}$.

vii. North by east of Meting. Survey-number $\frac{G\,280}{96}$.

viii. On the Railway six miles south of Bolárí. Survey-number $\frac{G\,280}{94}$.

ix. Picked up at Aongar hill, north of Jhirak (near the base of the group). Survey-number $\frac{G\,226}{163}$.

Illustrations of the Species in Plate XXXV.

Fig. 10. Abactinal view of the test: natural size.
11. Actinal view of the test: natural size.
12. Longitudinal profile of the test: natural size.
13. A portion of the abactinal surface, to show the apical disk and ambulacra. magnified.
14. Abactinal view of the test of a young specimen: natural size.
15. Actinal view of the same: natural size.
16. Longitudinal profile of the same: natural size.

2. METALIA SCUTIFORMIS, *d'Archiac*, sp. Plate XXXVI, Figs. 1–5.

Brissopsis scutiformis, *d'Archiac* (1850), *Hist. des progrès de la Géol.* t. iii. p. 251.
Brissopsis ? scutiformis, *d'Archiac & Haime* (1853), *Descrip. An. foss. de l'Inde*, p. 219, pl. xv, figs. 5 *a*, *b*.

MM. d'Archiac and Haime diagnosed the single specimen of this species known to them as follows:—

Body depressed, scarcely longer than broad, slightly expanded laterally in the median region, a little more elevated behind than in front, subbilobed anteriorly, feebly truncate posteriorly; apical disk almost central, odd anterior ambulacrum forming a wide and tolerably well-defined groove, granulated, pores distinct; petaloid ambulacra straight, narrow, tolerably large and sulciform, the lateral petals longer and more excavated than the posterior; poriferous zones tolerably broad, distinctly straight, subcostulate, twice as broad as the interporiferous area; pores very large and closely placed; peripetalous fasciole scarcely sinuous, and then only a little in front, rather irregular, touching the extremity of the petals. Lateral interambulacral areas much broader than the anterior, and especially than the posterior. Anus marginal; periproct large, rounded, a little higher than wide. Inferior disk almost flat, inflated along the median line in front of the anus; mouth situate at four elevenths of the major diameter from the anterior margin; peristome subelliptical; some peristomial ambulacral pores are noticeable. The only individual known was much rubbed; its length is a little more than 5 centimetres; its breadth 3 or 4 millim. less, and its height 2 centimetres.

No mention is made by d'Archiac and Haime of the large, complete, reniform subanal fasciole, enclosing about ten pairs of pores on either side of the subanal pastron, and with very well-defined radiating lines of tubercles in relation to the pores, with which this species is ornamented. The outline of the peripetalous fasciole is very incorrectly represented in the figure given in the 'Animaux fossiles' (plate xv, fig. 5 *a*). This fasciole really passes in a straight, unflexed line diagonally across the anterior interradia, and is bent with a sharp angle at the extremity of the antero-lateral petal;

after passing inward for some distance it is then abruptly bent to follow a line parallel with the margin of the petal, and this course is continued until near the inner third of the petal, when the fasciole is bent sharply backwards to cross the lateral interradia, passing finally round the extremity of the posterior petal and across the odd posterior interradium.

Remarks. Although there are a number of examples of this species in the collection from different localities, not a single one unfortunately is well-preserved, and nearly all are greatly weather-worn and damaged. We are consequently unable to add anything further to the foregoing observations. The species is readily distinguishable from its near ally *M. Sowerbyi* by the different form, and in having the posterior part of the test higher than the anterior, by the different proportions of the petaloid ambulacra, and by the different form of the peripetalous fasciole, which is deeply reentrant in the lateral interradia and unbent in the anterior interradia. A young example 18·5 millim. long exhibits all the characters of the larger specimens. It is of interest to remark that in no case hitherto have *M. Sowerbyi* and *M. scutiformis* been found associated at the same locality.

Dimensions.

	a. millim.	*b.* millim.	*c.* millim.	*d.* millim.	*e.* millim.	*f.* millim.
Length of the test .	46–48	42	41·5	41	40	18·5
Breadth of the test .	40·5	38	37	36	33·5	16
Height of the test .	23·5	18 ? (crushed)	18·5	22	19	10

Localities. In the Khirthar series of strata:—

i. North-east of Kale-ka-Kúa, seven miles south-east of Trak. Survey-number $\frac{G\ 302}{127}$.

ii. Mairi valley, south of Teyón. Survey-number $\frac{G\ 302}{101}$.

iii. Exact locality not known (*presented*), said to be near Kotri, probably the hills west of Kotri. Survey-number $\frac{G\ 280}{144}$.

iv. Near Meting Railway-Station. Survey-number $\frac{G\ 280}{112}$.

v. Keúhír-ka-lak (pass), east side of Súrjána range. Survey-number $\frac{G\ 280}{74}$.

vi. Eight or nine miles south by west of Jangri, and east of the Súrjána range. Survey-number $\frac{G\ 280}{73}$.

vii. Twenty-four miles west of Kotri (entering the hills on the road to Búla Khán's Thána). Survey-number $\frac{G\ 280}{72}$.

Illustrations of the Species in Plate XXXVI.

Fig. 1. Abactinal view of the test: natural size.
2. Actinal view of the test of another specimen: natural size.
3. Longitudinal profile of the test: natural size.

Fig. 4. The apical disk: magnified.
5. A portion of the abactinal surface, to show the antero-lateral petal and the fasciole: magnified.

3. **Metalia scutiformis** (?) var. **rotunda**, *Duncan & Sladen*. Plate XXXVI, Figs. 6 & 7.

There is in the collection a single large specimen of a much-weathered test, the outline and general facies of which are alone observable, all detail being either obscured or destroyed: This form we place provisionally as a variety of *M. scutiformis*, though it is quite possible that better material might warrant its recognition as a distinct species.

The marginal contour of the test is more rotund and more prominently expanded laterally than in the normal form of the type species. The length of the test was probably very little greater than the breadth, but the exact proportions are obliterated in consequence of some crushing at the posterior extremity having produced a distortion, which extends also on the actinal surface. Seen in longitudinal profile the characteristic prominence of the odd posterior interradium is conspicuous, and the general outline of the abactinal surface conforms closely with that of *M. scutiformis*. The antero-lateral petals are equal to or slightly longer than the posterior pair, and the furrow of the odd anterior ambulacrum is very shallow.

Dimensions. The length of the test (crushed) is 50·5 millim., the breadth 49·5 millim., and the height 23 millim.

Locality. In the Khirthar series. Súmbak Hill, south-west of the Vero plain. Survey-number $\frac{G\ 226}{139}$.

Illustrations of the Specimen in Plate XXXVI.

Fig. 6. Abactinal view of the test: natural size.
7. Outline of the longitudinal profile of the test: natural size.

4. **Metalia depressa**, *Duncan & Sladen*. Plate XXXVI, Figs. 8–10.

Test of medium size. Marginal contour ovally subhexagonal, prominently expanded laterally, slightly indented anteriorly by the anteal sulcus, broadly truncate posteriorly. The greatest breadth is slightly anterior to the centre, and is about nine tenths of the length, or in the proportion of 0·91 : 1. The dorsal surface is depressed, its convexity being of slight elevation; the apical summit of the test is excentric in front, and corresponds with the apical disk, the height being rather more than two fifths of the length. When seen in longitudinal profile the slope on either side in the neighbourhood of the apex is very slight; a distance away anteriorly, however, a well-developed curve passes rapidly to the margin and forms a full and well-rounded anterior extremity. The posterior slope is very slight until close to the margin, where it is abruptly rounded at the truncate posterior extremity. The transverse profile shows a uniform convex curve, slightly flattened laterally. The actinal surface appears to have been almost flat, and is well rounded at the margins.

The apical disk is excentric in front, its distance from the anterior margin being about three eighths of the longitudinal diameter of the test. The four generative pores are very closely placed, the posterior pair being slightly wider apart than the anterior pair. The five ocular pores are remarkable for their large size, being quite equal to the generative pores. The pore corresponding to the odd anterior ambulacrum is placed in front of the anterior pair of generative pores, forming with them a triangle. The posterior pair of ocular pores are very wide apart, being separated by the extensive prolongation of the central madreporiform body; and the position of each of these pores is in a line with the two generative pores on its own side of the median line and the odd anterior ocular pore; there being thus two converging lines of four pores, counting the odd anterior pore twice. The lateral pair of ocular pores are external to the anterior pair of generative pores.

The groove of the odd anterior ambulacrum is very shallow and feebly defined. The poriferous zones are straight, with the pores very minute and the pairs comparatively closely placed.

The petaloid ambulacra are comparatively short and are sunken in deep grooves, the margins of which are rounded or bevelled, as it were, on to the general area of the interradia. The anterior pair are slightly longer than the posterior pair; they proceed in a straight line from the apex towards the margin, are very widely divergent, and subtend an angle of about 130°. The posterior petals inclose an angle of about 52°, are rather shorter than the anterior, and their course is straight from the apex towards the margin. The poriferous zones of the petaloid ambulacra are wide, straight, and equal, with pores transversely oval, wide apart, and united by a well-defined conjugating groove, adjacent pairs and grooves being separated by narrow costæ bearing a series of small ill-defined granules. The poriferous zones diminish slightly in breadth at the extremities, but in the case of the anterior zones of the anterior pair of petals the decrease in size at the apical extremity is considerable and rapid, seven or eight pairs being almost entirely aborted. Furthermore, a few pairs are aborted in all the zones at the apical extremity, which gives a singular and disconnected appearance to the apical disk. The interporiferous areas are narrow, and their width is less than the distance of the pores apart.

The peristome is large and more excentric in front than the apical disk, but unfortunately the neighbouring portions of the test are destroyed and no further observations are possible.

The periproct is large, subcircular, and placed at the extreme summit of the posterior extremity, the diameter of the aperture being nearly equal to half the apparent depth. At the sides of the aperture the test is more coarsely tuberculated than the general surface of the interradia; and beneath the periproct, where a slight depression occurs, there is some coarse and widely spaced tuberculation also.

Two fascioles are present—peripetalous and subanal. The peripetalous fasciole is only slightly sinuous in the lateral interradia, where a sharp, short, double bend at right angles takes place near the middle of the anterior column of plates of the interradium. Within the boundary of the fasciole some large isolated tubercles are present in the interambulacral areas, the greatest number being found on either side of the odd anterior ambulacrum, where they are also comparatively smaller and more grouped than elsewhere. In the lateral interradia there are a considerable number on the flank of the groove of the postero-lateral petal, where several transverse lines of two, three, or even four tubercles are placed. Similar, but less numerous, tubercles occur on the other flank of the posterior petals and on each of the flanks of the anterior pair. There are also a few large tubercles outside the fasciole in the lateral interradia, appearing like a continuation of those on the posterior flank of the antero-lateral petal. Similarly a few smaller tubercles are found outside the fasciole on either side of the median suture of the odd posterior interradium. The subanal fasciole is very wide and subreniform; the length of the subanal plastron, or, in other words, its measurement along the longitudinal axis of the test, not being more than one fourth of its width or transverse measurement. Six or seven pairs of ambulacral pores are included on either side of the area, and the tubercles which ornament the plastron are large, distinct, and more or less definite in their arrangement.

The general ornamentation of the test on the abactinal surface is small, uniform, and crowded, becoming larger and more distinct at the margins, where it is also sublineal in arrangement; on the actinal surface it is much larger and more widely spaced, but unfortunately very little detail remains on the latter region of the specimen under notice.

Remarks. This species is so well distinguished, either from *M. Sowerbyi* or *M. scutiformis*, by the general depression of the test, by the different marginal contour, ambulacral petals, fascioles, and ornamentation, that it appears superfluous to compare these points seriatim.

Dimensions. Length of the test 41·5 millim., breadth 38 millim., height 17·5 millim.

Locality. In the Khirthar series of strata: East of Band Vero, north-west of Kotri. Survey-number $\frac{G\,226}{151}$.

Illustrations of the Species in Plate XXXVI.

Fig. 8. Abactinal view of the test: natural size.
9. Longitudinal profile of the test: natural size.
10. A portion of the abactinal surface, to show the apical disk, the ambulacral petals, and the fasciole: magnified.

5. METALIA AGARICIFORMIS, *Duncan & Sladen.* Plate XXXVI, Figs. 11–14.

The collection contains several specimens of *Metalia*, all unfortunately much weathered and broken, but which we do not hesitate to place as a distinct species, although, unfortunately, we are only able to give a very imperfect description. The following are the characters which are noticeable.

The marginal contour of the test is subrotund, scarcely indented in front and faintly truncate behind. The length and the breadth are subequal. The test is subdepressed, and the greatest height, which is slightly excentric behind, is about equal to half the length; the abactinal surface is convex and regularly arched from the apex to the thin angular margins. Seen in longitudinal profile the anterior slope, which passes through the apical disk, is rather less full and less rapid than the posterior slope, and when seen in transverse profile the slightly prominent carination of the odd posterior interradium is noticeable. On the actinal surface there is a very marked declivity or inclination of the test around the peristome, especially anteriorly, which gives a remarkable appearance to the species.

The apical disk is slightly excentric in front; the two anterior generative pores are rather wide apart and separated by the odd anterior ocular plate; the posterior pair of generative pores are rather wider apart than the anterior pair; and the posterior pair of ocular pores are separated by the central madreporiform body. The ocular pores are minute and almost microscopic.

The odd anterior ambulacrum lies in a very slight depression of the test, which can scarcely be called a groove, and the grooves of the petaloid ambulacra are almost as shallow and ill-defined; these latter appearing, however, to be rendered visible by the slight tumidity, verging on carination, which occurs along the median line of the interradia.

The anterior pair of petals are a little longer than the posterior pair, having two or three more pairs of pores in each zone; they are very widely divergent, subtending an angle of about 160°, and the general course of the petal is almost straight from the apex towards the margin, although a certain appearance of curvature is produced by the rapid abortion of the seven or eight terminal pairs of pores at the apical extremity of the anterior zones. The pores in each zone are equal, transversely oval, and wide apart; the pores of a pair are united by a conjugating furrow, and adjacent pairs separated by divisional costæ, and the width of the interporiferous area is about equal to the distance of the pores apart. In the posterior petals two or three pairs of pores are aborted in each zone at the apical extremity, and the succeeding pores are smaller, increasing in size more gradually in the posterior zone than in the anterior zone, producing the appearance of more extended abortion; but the character is much less conspicuous than in the anterior zones of the anterior pair of petals. The posterior pair of petals subtend an angle of about 40°.

The peristome is excentric in front and situated in a well-defined and rather deep depression of the test; the anterior lip is semicircular; the posterior lip is unfortunately destroyed. The five or six terminal pores of each ambulacral zone near the peristome are large and situated in cavities, and form in each ambulacrum a pair of uniserial lines of pores, which diverge apart as they approach the peristome.

The position and character of the periproct is undeterminable, as the upper part of the posterior extremity is wanting.

The posterior peak of the actinal plastron is rather prominent, and the longitudinal diameter of the subanal plastron appears to have been small, probably about one fourth of the transverse diameter. About four pairs of ambulacral pores are present on either side of this plastron, although no trace of the subanal fasciole, whose presence is thus demonstrated, can be made out.

The peripetalous fasciole is obliterated, as well as the whole of the ornamentation of the abactinal surface.

Remarks. This form is readily distinguished from the species previously described by the shape of the test, both in marginal outline and in the character of the abactinal surface, by the structure of the anterior pair of petals, by the thin angular margin, and by the depression around the peristome. There appears to be some variation in the position of the apical summit of the test, which in one specimen at least corresponds with the position of the apical disk; and there is also in the same example a slight curvature near the apex in the anterior zone of the posterior petals, which causes them to have a rather thicker appearance than in the test we have described above.

Dimensions. The largest specimen measures 30·5 millim. in length, 30 millim. in breadth, and 15 millim. in height.

Localities. In the Khirthar series of strata:—i. Three or four miles south-south-east of Meting (at base of the scarp). Survey-number $\frac{G\ 280}{111\ c}$.

ii. Aongar-hill scarp, east of Meting Railway-station (base of scarp). Survey-number $\frac{G\ 280}{99\ \bullet}$.

Illustrations of the Species in Plate XXXVI.

Fig. 11. Abactinal view of the test: natural size.
12. Actinal view of the test: natural size.
13. Longitudinal profile of the test: natural size.
14. A portion of the abactinal surface, to show the apical disk and the ambulacral petals: magnified.

6. Metalia, sp. Plate XXXVI, Figs. 15 & 16.

There is a single test of a *Metalia* in the collection, which unquestionably belongs to an undescribed species; but its state of preservation is so bad that a proper diagnosis is impossible, and we have consequently refrained from giving it a name until better material is available. Two drawings of the specimen have been given to facilitate future identification, and the following details are all that can be observed.

The marginal contour is rotund, rather angularly expanded laterally, the greatest breadth nearly equal to the length. The anterior margin is sharply indented by a well-defined anteal sulcus, and the posterior extremity is slightly truncate. The greatest height of the test is thrown far forward close to the anterior margin, so that in the longitudinal profile the anterior extremity is seen to be a very steep and almost precipitous incline, passing with a rapid and sharply rounded curve from the dorsal surface. The posterior slope is long and even, forming a gradual incline to the posterior extremity. The abactinal surface is much depressed, the greatest height being two fifths of the length, and the margins are thin and sharply rounded.

The apical disk is excentric in front, but much less so than the apical summit. All the structure is destroyed.

The odd anterior ambulacrum is situated in a deep and sharply defined groove, which disappears, however, at the apex. The petaloid ambulacra are in moderately deep grooves, those of the posterior pair having a scooped-out appearance in consequence of the greater depression midway between the extremities. The anterior pair of petals are longer than the posterior pair; they proceed straight from the apex towards the margin, and are very nearly horizontal, the angle subtended being about 155°. The poriferous zones are broad; the pores large, equal, oval, united by a conjugating groove, and the pairs separated by ridge-like costæ. There is a very sudden and great abortion of the seven or eight terminal pairs of the anterior zone at the apex of the anterior petals, and two or three pairs are aborted in the companion zone. In the posterior pair of petals about two pairs of pores are aborted in the anterior zone and three pairs in the posterior zone. The interporiferous areas are narrow, their width being not greater than the distance of the pores apart in the poriferous zones, and the areas in the posterior petals are perhaps a shade narrower than in the anterior petals.

A great portion of the actinal surface is obscured by matrix; such portions, however, as are exposed lead to the supposition that the ambulacral areas on the actinal surface were in slight depressions, whilst the intervening interradial areas were slightly tumid.

Traces are discernible of the peripetalous and of the subanal fascioles; the latter was of wide extension, and included four or five pairs of ambulacral pores on either side.

Traces of the ornamentation may be seen on the abactinal surface near the margin, where the miliary tubercles appear moderately large and distinct; and along the flanks of the groove of the odd anterior ambulacrum the tuberculation is larger than the general miliary tuberculation. As usual, the tubercles are much larger on the actinal surface; and there was probably in this species some rather coarse granulation in the ambulacral areas on either side of the actinal plastron.

Dimensions. Length of the test 40 millim., breadth 38·5 millim., height 16 millim.

Locality. In the Khirthar series of strata: Near Meting Railway-station. Survey-number $\frac{G\,280}{112}$.

Illustrations of the Specimen in Plate XXXVI.

Fig. 15. Abactinal view of the test: natural size.
16. Longitudinal profile of the test: natural size.

7. Metalia, sp. Plate XXXVI, Fig. 17.

There is a single and much weathered fragment of a test which we consider to belong to a species of *Metalia* distinct from any of the foregoing. The fragmentary and badly preserved state of the fossil render the specimen insufficient for specific diagnosis; hence, until better examples are forthcoming, we limit our reference to this species to the following brief remarks.

The most striking feature of the fragment consists in the long straight postero-lateral ambulacral petals, which are placed in well-defined but not very deep depressions, and are equal to or even slightly longer than the anterior pair. The poriferous zones are very wide, and the interporiferous areas remarkably narrow, being little, if at all, wider than the divisional costæ which separate the widely spaced and conjugate pairs of pores. Two or three pairs of pores are aborted at the apical extremity of each zone. The apical disk is excentric in front; the ocular pores are in sunken cavities, and the posterior pair are separated by the posterior extension of the madreporiform body. The posterior pair of generative pores are larger and wider apart than the anterior pair. The apical summit of the test apparently coincided with the apical disk; and the posterior slope of the test, when seen in longitudinal profile, is very slight, the posterior extremity being high and thick; the margins also are thick, and somewhat tumid for this genus. The peripetalous fasciole is narrow, and was probably devoid of any sinuous bend in the lateral interradia; and there appear to be traces of a few large isolated tubercles on the flanks of the ambulacral grooves. The subanal fasciole is extensive, and includes seven or eight pairs of ambulacral pores on either side; and there are traces of distinct grooves radiating inwards from the pores. The actinal plastron is rather prominent at the posterior peak, and its outline inward is defined as the apex of a triangle by the broad posterior ambulacral areas.

Perhaps the nearest alliances of this form are to *M. Sowerbyi*, from which, however, it differs by the length and character of the posterior petals, as well as by the height and thickness of the posterior extremity and the margins generally; moreover, the test is much larger than that of *M. Sowerbyi* as at present known.

Dimensions. From the centre of the apical disk to the posterior extremity 30 millim., breadth rather more than 41 millim., height 24 millim.

Locality. In the Khirthar series of strata: Three or four miles north-east of Júngsháhi Railway-station. Survey-number $\frac{G\ 226}{107}$.

Illustration of the Specimen in Plate XXXVI.

Fig. 17. Abactinal view of the specimen: natural size.

Genus LINTHIA, *Merian*, 1853.

(See *antea*, p. 17, Part i.)

1. **Linthia orientalis**, *Duncan & Sladen.* Plate XXXVII, Figs. 7–14.

Test of medium size. Marginal contour rotundly subcordiform, widely expanded laterally, the breadth being slightly greater than the length, deeply indented anteriorly by the anteal sulcus, contracting behind the line of greatest breadth towards the posterior extremity, which is slightly truncate. The abactinal surface is convex, more or less inflated, and deeply incised by the ambulacral grooves. The greatest height of the test, which is slightly excentric posteriorly, lies on the keel of the odd posterior interradium, and is nearly equal to two thirds of the length, or in the proportion of 0·64 : 1. Seen in longitudinal profile the anterior slope is steep and rapid, the lateral interradia are slightly keeled and prominent at the apex, and the posterior portion of the profile, which is formed by the odd posterior interradium, is convex, well arched, curving with a well-rounded bend to the summit of the high, truncate posterior extremity. The actinal surface is slightly convex, caused by a faint tumidity in the actinal plastron; and there is a slight depression in front of the peristome. The margins are full and tumid.

The apical disk is slightly excentric in front, and has four generative and five ocular plates; the anterior pair of generative plates are separated by the odd anterior ocular plate; the posterior pair of generative plates and pores are slightly larger and wider apart than the anterior pair, to which they are very closely placed; the posterior pair of ocular plates stand immediately beneath, and are separated by the posterior prolongation of the central madreporiform body.

The odd anterior ambulacrum is placed in a wide, deep, and well-defined groove, which extends from the apex, deeply indents the margin, and is continued below the ambitus as a shallow channel reaching up to the peristome, the anterior interradial areas in the actinal surface being somewhat tumid in relation to this groove of the odd anterior ambulacrum. On the abactinal surface this groove is of very uniform width from the apex to the margin, and its floor has a comparatively flat appearance. The poriferous zones are straight and parallel, except near the apex, where they converge. The pores are very minute, those of a pair being placed in a small oval cavity, the series of these giving the zone the appearance of being composed of large single pores. The interporiferous area is wide, and is ornamented with a few very minute and erratically placed granules, which are of two sizes, the smaller being more numerous and more crowded. The petaloid ambulacra are comparatively long and straight, placed in deep, sharply-defined grooves, which contract rather rapidly at the apical extremity, and also, but in a less degree, at the outer extremity, where the groove shallows gradually. The anterior pair of petals are slightly longer than the posterior pair, and extend straight from the apex nearly to the margin; they are widely divergent, and subtend an angle of about 135°. The poriferous zones are broad, and occupy the flanks of the grooves. The pores are subequal, and transversely oval, rather wide apart, and united by a very broad conjugating groove, adjacent pairs being separated with ridge-like divisional costæ, which bear a single series of small, ill-defined granules. The pairs of pores are comparatively rather widely spaced. The pores of a pair diminish in size and distance apart as they approach the apex, and also, but to a less extent, at the outer extremity. The interporiferous area is a shade wider than the poriferous zone, and is only about half the width of the same area in the odd anterior ambulacrum; it appears to have been smooth, as no trace of miliary granulation is to be found in the specimens at our disposal. The posterior pair of petals are similar to the anterior pair, but are rather shorter and rather more contracted towards the outer extremity; their course from the apex towards the margin is straight, and they subtend an angle of about 54°. There are 24 or 25 pairs of pores in a zone of the postero-lateral petals, and 29 or 30 pairs in a zone of the antero-lateral petals.

All the interradia have a flatly tumid appearance, and become subcarinate near the apical disk; the odd posterior interradium is more tumid than the others along the median longitudinal line, and forms between the posterior pair of petals a well-developed convex, hog-backed ridge.

The peristome is very excentric in front, nearer the anterior than the lateral margins of the test; it is bilabiate, with the posterior lip broad, well arched, moderately prominent and tumid, the anterior lip semicircular, and the neighbouring portions of the test sloping inwards.

The periproct is of moderate size, transversely oval, and placed at the summit of the posterior extremity, the upper margin being slightly overhung by the test, and the angle of truncation of the posterior extremity is slightly directed inwards, which gives an overhanging character to the whole extremity; beneath the periproct there is a slight concavity in the test, which causes some tumidity to appear on either side of the extremity near the margin.

There are two well-developed fascioles on the test—one peripetalous, and the other latero-subanal. The peripetalous fasciole is very sinuous; it crosses the groove of the odd anterior ambulacrum a short distance above the ambitus, traverses the anterior interradia with a concave curve, bends sharply round the antero-lateral petals, and after proceeding for a short distance beyond their extremity, is bent at right angles to run parallel with the groove nearly up to the inner fourth of the petal; it is then again bent at right angles, and proceeds nearly parallel with the longitudinal axis of the test until it curves sharply round the extremity of the postero-lateral petal, and passes far up into the odd posterior interradium with a deeply reentering curve to cross the keel and pursue a similar course on the other side of the test. The latero-subanal fasciole joins the peripetalous fasciole at its sharp angular bend behind the extremity of the antero-lateral petal, and proceeds thence in a direct course backwards and downwards towards the posterior extremity, and passes beneath the periproct.

The ornamentation on the abactinal surface is small, crowded, and comparatively uniform, consisting of small primary tubercles with mamelons and disk-like scrobicules, and with small, uniform, widely spaced, and irregularly disposed miliary granules in the interspaces. On the actinal surface the primary tubercles are much larger and more widely spaced, and the intervening miliary granules are more numerous and crowded.

Remarks. This species has some resemblance to the Egyptian form *Linthia cavernosa* described by de Loriol; but the Indian species is more widely expanded laterally, and has much more deeply and definitely grooved ambulacra, and also appears to be more tumid posteriorly. The forms are probably representative species. *Linthia orientalis* has likewise some affinity with *L. Ybergensis* of de Loriol, from the Nummulitic of Switzerland, but is distinguished by its more depressed test, by the narrower petals placed in more sharply defined grooves, by the more excentric apex, and by the different characters of the posterior extremity and marginal contour.

As illustrative of the elasticity of form in this species, we have given drawings of two remarkable monstrosities, in both of which an oblique development of parts has taken place. The smaller of the two examples is also peculiar on account of its high and conical abactinal surface, the longitudinal profile simulating in outline that of some forms of *Conoclypeus*.

Dimensions. The largest specimen measures 45 millim. in length, with greatest breadth 46 millim. and height 29 millim. The antero-lateral petals are 21 millim. in length, and the postero-lateral 18 millim.; the greatest breadth of the latter is 5 millim., or a shade less.

Localities. In the Khirthar series of strata:—i. Roïs Hill, near Damaj, south of Búla Khán. Survey-number $\frac{G\,302}{119}$.

ii. Baili, west of Tóng. Survey-number $\frac{G\,304}{23}$.

Illustrations of the Species in Plate XXXVII.

Fig. 7. Abactinal view of the test: natural size.
8. Actinal view of the test: natural size.
9. Longitudinal profile of the test: natural size.
10. Odd anterior ambulacrum: magnified.
11. Portion of one of the petaloid ambulacra: magnified.
12. Apical disk: magnified.
13. Abactinal view of an abnormal unsymmetrical test: natural size.
14. Abactinal view of another abnormal unsymmetrical test: natural size.

Genus SCHIZASTER, *Agassiz*, 1836.

(See *antea*, p. 86, Part ii.)

1. SCHIZASTER SYMMETRICUS, *Duncan & Sladen.* Plate XXXVII, Figs. 15–21.

Test of small or medium size. Marginal contour oval, elongate, deeply indented anteriorly by the anteal sulcus, rather more contracted towards the posterior extremity, which is subrostrate, and more or less protuberant. The abactinal surface is not very high, and when seen in longitudinal profile forms a well-arched curve, sloping gently from the highest point, which is excentric posteriorly, to the anterior extremity, which is thick and tumid. Immediately behind the highest point, the outline is slightly curved, and is then abruptly truncate obliquely at a steep angle of inclination, which extends to the ambitus, the area thus formed being more or less concave; beneath the ambitus the inferior margin of the posterior extremity is rounded off to merge into the actinal surface, and is tumid and protuberant. The sides of the test are tumid, and the actinal surface convex.

The apical disk is almost subcentral, or very slightly excentric posteriorly. There are only two generative pores, which are very large, and borne on hexagonal plates, which correspond with the postero-lateral interradia. The anterior pair of generative pores are aborted. The ocular plates are subpentagonal, and the posterior pair are separated by the central madreporiform body.

The odd anterior ambulacrum is situated in a wide and deeply excavated groove, the floor of which is but slightly rounded, and is bounded by the high thin ridge-like keels of the anterior interradia. The poriferous zones are placed in the rounding which unites the floor and the sides of the groove; the pores are small, and have a tendency to become slit-like, especially the inner series. The pores of a pair are separated by a high, prominent, pedunculated granule, which has a slight inclination towards the outer pore in the direction of the apex; and the pairs of pores are situated in faint oblique depressions. All the pairs are well spaced throughout the zone, but are closer at the apical extremity. The interporiferous area is ornamented with a few minute and widely spaced miliary granules, amongst which a few larger ones are occasionally to be found. The anterior pair of ambulacral petals are large, wide, petaloid, situated in deep well-defined grooves, and are rather divergent for the genus. The anterior poriferous zone is bent with a graceful sigmoid curve, and the companion posterior zone is abruptly rounded at a short distance from the apical disk. The poriferous zones in the middle of the petal are very broad; and the pores are wide apart and slit-like: they are indistinctly conjugate, and adjacent pairs are separated by a very low and scarcely definite costa, which does not appear to extend beyond the inner half of the zone, or, in other words, only the inner series of pores are separated by it. The interporiferous area is much narrower than the width of the poriferous zone, and is devoid of ornamentation.

The posterior pair of petals are small, elliptical or subpyriform in outline, with their outer extremity well rounded, and the apical extremity rapidly contracting to a point. The course of the petal from the apex towards the margin is straight, and with no tendency to flexure, and the petals are separated only by the thin narrow ridge of the odd posterior ambulacrum. The poriferous zones are similar in character to those of the anterior petals, but the inner series of pores form a straight line, whilst the outer form the well-developed curve which defines the outline of the petal. There are 19 pairs of pores in a zone of the posterior petals against 24 pairs in the anterior petals, the ambulacral plates being smaller and the pairs of pores much closer together in the former.

The paired interradial areas have all their plates on the abactinal surface more or less gibbous, which produces a vertical series of knobby prominences in each of the columns of interambulacral plates, and these are most conspicuous as they approach the ambitus. On the inner portion of the anterior interradia the two series of prominences become merged into one to form the thin, sharp, keel-like ridge that separates the odd anterior groove from the antero-lateral petal; and at the apical extremity the keel tapers off gradually to the level of the apical disk. There is a similar keel at the apical extremity of the lateral interradia, but it is short, narrow, flat on the upper surface, and likewise tapers down to the level of the apical disk. The keel of the odd posterior interradium, which is narrow, rather high and ridge-like, gradually expands and disappears over the summit of the oblique posterior truncation. The general area of this truncation is concave, and the margins on the lower half are defined by gibbosities on the plates, which are also present on the plates of the tumid inferior prominence beneath.

The periproct is comparatively small, vertically elliptical, and is placed at the summit of the concave posterior truncation.

The peristome is very excentric in front; the regions of the ambulacra on the actinal surface are conspicuously naked; and the actinal plastron is more or less tumid, and becomes gibbous at the culminating point posteriorly. The figure of the abactinal surface given on the Plate is considerably restored from a very badly crushed example, the detail of which is only preserved fragmentarily.

There are two fascioles present—a peripetalous and a latero-subanal. The peripetalous fasciole is broad, and closely embraces the ambulacral petals, crossing the anterior interradia at a short distance external to the apparent bifurcation of the gibbous keel, and bisecting the groove of the odd anterior ambulacrum just before the rounding of the anterior margin commences. The lateral fasciole is a very thin, narrow band, which joins the peripetalous fasciole behind the extremity of the antero-lateral petals, crosses the lateral interradia through the two uppermost prominent gibbosities, and passes thence beneath the periproct, traversing the inferior margin of the concave area.

The ornamentation on the abactinal surface is uniformly small, excepting along the inner flanks of the keels which bound the odd anterior groove, where some larger tubercles are present. On all the gibbose plates of the interradia the tuberculation is smallest at the summit of the prominence, and increases in size as it recedes therefrom. All the ornamentation increases in size and in distance apart as it approaches the ambitus, especially in the anterior region; and the primary tubercles become larger and widely spaced on the margins of the actinal surface. On the actinal plastron a more or less definite arrangement of lines radiating from the culminating point is maintained; the size of the tubercles increasing as they approach the peristome, those near the culminating point being the smallest.

Remarks. It is not without hesitation that we have ranked this form as a *Schizaster*—the subcentral apical disk, the comparatively divergent anterior petals, and the rather long posterior petals being abnormal for the genus. On the other hand, the deeply excavated ambulacra, the carinate keels of the interradia, the character of the ornamentation, and of the apical disk are all more clearly allied to *Schizaster* than to *Linthia*; and we have consequently placed the form in accordance with what seem to us the sum of its affinities. In sequel to these remarks it is interesting to note that *S. symmetricus* has rather a strong resemblance to *Linthia Navillei*, described by de Loriol from Egypt, in so far as the shape of the test is concerned; but the Indian species differs in being more depressed, in the shorter and more precipitous truncation, in the depth and character of the ambulacral grooves, and in the more excentric apical disk. We know of no species with which it can be confounded, and it is very distinct from the other Indian forms.

Dimensions. Length of test 30·5 millim., breadth 28 millim., exact height indeterminable.

Locality. In the Khirthar series of strata: Eight or nine miles south by west of Jangri, and east of the Súrjána range. Survey-number $\frac{G\,280}{73}$.

Illustrations of the Species in Plate XXXVII.

Fig. 15. Abactinal view of the test: natural size.
16. Actinal view of the test: natural size.
17. Longitudinal profile of the test: natural size.
18. The test seen from behind.
19. Odd anterior ambulacrum: magnified.
20. Portion of one of the petaloid ambulacra: magnified.
21. Apical disk: magnified.

2. SCHIZASTER SIMULANS, *Duncan & Sladen*. Plate XXXIV, Figs. 15 & 16.

There is a single badly-preserved and broken test of *Schizaster* in the collection, which is so well marked that we have ventured to name it, although the condition of the fossil is unsuitable for description, and our remarks are consequently limited to such characters as may be observed.

The test is of medium size, having the marginal contour oval, deeply indented in front, and rather contracted posteriorly. The apical disk is only slightly excentric posteriorly. Seen in longitudinal profile, the greatest height occurs near to the posterior extremity, and the abactinal area slopes thence gradually to the comparatively thin anterior margin. The general character of the test is decidedly depressed for the genus, and the margins are comparatively thin and almost angular in their rounding. The groove of the odd anterior ambulacrum is deep and narrow. The anterior pair of petaloid ambulacra are deep, wide, and well rounded at the outer extremity, and contract gradually at the apical extremity; and the petals as a whole are comparatively slightly curved, and rather widely divergent. The posterior pair of petals are small, subelliptical in outline, and only slightly divergent, and are separated by the ridge-like carination of the odd posterior interradium.

The anterior and the lateral interradia are not prominently keeled, although their narrowness at the apex, combined with the depth of the grooves of the petals, simulate that appearance near the apical disk. From the point of greatest height the odd posterior carination is abruptly rounded to the posterior extremity, where the test is prominent and overhangs the periproct. This aperture is placed at the summit of the high posterior truncation; the area beneath is more or less incurved, and the inferior margin of the extremity, which is sharply rounded, is not quite vertically beneath the prominence of the superior or dorsal portion of the extremity, but is slightly less prominent and nearer the centre, and the general plane of truncation consequently trends inwards. The comparatively broad actinal surface is more or less tumid along the longitudinal line, the actinal plastron being convex. The peripetalous fasciole closely embraces the ambulacral petals, entering deeply into the lateral interradia. The latero-subanal fasciole is very high in position, passing with a convex curve at a high level, almost into the interpetalous area of the lateral interradia.

Remarks. Notwithstanding the scanty details enumerated above, they are sufficient to indicate that the *Schizaster* in question is clearly distinct from any of the other

Indian forms; and although we hesitate from drawing definite comparisons with western species, we venture to believe that when more perfect specimens are studied, and such comparisons are possible, *S. simulans* will prove to be readily distinguishable.

Dimensions. Length of the test 40·5 millim., breadth 37 millim., height about 24·5 millim.

Locality. In the Khirthar series of strata: Baili, west of Tóng. Survey-number $\frac{G\,304}{23}$.

Illustrations of the Species in Plate XXXIV.

Fig. 15. Abactinal view of the test: natural size.
16. Longitudinal profile of the test: natural size.

3. Schizaster Baluchistanensis, *d'Archiac & Haime.*

We refer to this species a single small test of *Schizaster*, the preservation of which is, however, so bad as to be quite unfitted for illustration, and the determination is based entirely upon its general form and character. As the species occurs in other strata, and has been noticed by us in the description of the Fossil Echinoidea of Kachh and Kattywar, further remarks are here unnecessary.

The Khirthar example is of small size, its length being about 28 millim.

Locality. In the Khirthar series of strata: Pújána lak (pass), east side of Hothian Hill. Survey-number $\frac{G\,280}{83}$.

4. Schizaster (?), sp. Plate XXXVI, Figs. 20 & 21.

There is a single badly preserved test in the collection which is unquestionably distinct from any of the other Indian Echini, but the condition of the fossil is such that any useful description is impossible, and we are in great doubt even as to its generic position. The form has been placed provisionally as a *Schizaster* mainly on account of the shortness of the posterior pair of petals and the apparent trend of the anterior pair. There appear also to be indications suggestive of the former presence of a fasciole passing below the periproct, but this statement is purely conjectural. As no useful remarks are possible on such an unintelligible fossil, it is obviously necessary to await the receipt of more perfect specimens before any specific diagnosis can be given; meanwhile the figures of the fossil in question contained in Plate XXXVI. will serve for the identification of the form.

Dimensions. Length of the test 50 millim., breadth 45 millim., height 32·5 millim.

Locality. In the Khirthar series of strata: About seven miles north-east of Búla Khán's Thána. Survey-number $\frac{G\,226}{113}$.

Illustrations of the Species in Plate XXXVI.

Fig. 20. Abactinal view of the test: natural size.
21. Longitudinal profile of the test: natural size.

There is another test, equally indeterminable, from the same locality; it is of much smaller size, only 17 millim. in length, and may or may not belong to the same species. From what can be observed of its shape, however, we are inclined to think that it is probably the young of the same form as the larger test noticed above.

Genus MOIRA, *A. Agassiz*, 1872.

There is a fairly well-preserved fragment of a test unquestionably belonging to this genus included in the collection of Echinoidea from the Khirthar series of strata in Sind. From the appearance of the matrix, however, we have very strong doubts as to the accuracy of the assignment of this fossil to the Nummulitic series, and would urge caution before it is definitely included as a member of the Khirthar fauna. If, however, the horizon accredited to the specimen under notice be correct, this fragment is interesting as being the earliest representative of the genus with which we are acquainted.

A species of *Moira* (*M. antiqua*, nobis) occurs abundantly in the Miocene strata of Kachh, and has recently been described by us in our work on the Tertiary Fossil Echinoidea of that province. The present form is specifically distinct; but we are unfortunately unable to furnish a complete diagnosis, as little more than one side and a portion of the abactinal surface of our specimen remains. Our description is necessarily limited to the few striking characters preserved, and is in a large measure comparative, having reference to the Miocene form.

1. Moira primæva, *Duncan & Sladen*. Plate XXXV, Figs. 1–3.

Test rather small, marginal contour decidedly oviform; the test being longer and more contracted, and more definitely pointed posteriorly than in *M. antiqua*. Furthermore the test is not so widely expanded laterally behind the anterior petals, and is more gradually contracted anteriorly. The dorsal height appears to be less, and the curvature of the abactinal surface less bombous in its slope to the anterior margin, which is comparatively sharp and angular. The odd anterior ambulacrum forms a very deep pit in front of the apical disk; and the upper margins of the groove are comparatively wide apart, and appear to be less contracted as they approach the apex than is the case in the Kachh form.

The grooves of the lateral petals are very narrow and slit-like, and do not become wider at their distal extremity. The posterior pair appear to be proportionately longer in relation to the anterior pair than in *M. antiqua*. Both pairs of petals are also rather more divergent,—the anterior pair of grooves subtending an angle of about 108°, and the posterior one of about 50°.

The characteristic lineal ornamentation of the genus is well preserved in our specimen, and it is small and homogeneous.

Dimensions. The length of the test is 24 millim., and the height about 17 millim.

Locality. In the Khirthar series of strata (?): Twenty-four miles west of Kotri (entering the hills on the road to Búla Khán's Thána). Survey-number $\frac{G\ 280}{72}$.

(The matrix, which is arenaceous and of a grey colour, is altogether different from that of any of the large series of specimens obtained from this locality; and it appears almost unquestionable that the assignment of this specimen to the Khirthar series results from an accident in labelling.)

Illustrations of the Species in Plate XXXV.

Fig. 1. Abactinal view of the test: natural size.
2. Longitudinal profile of the test: natural size.
3. Ornamentation of the plates in the lateral interradium: magnified.

Genus BRISSOPATAGUS, *Cotteau*, 1863.

Test of medium size, oval, moderately inflated above, almost flat beneath, subcarinate in the posterior region.

Ambulacral summit excentric in front. Anterior sulcus not defined on the dorsal surface, but tolerably deep near the ambitus. Anterior pair of petals short, widely divergent, curved, situated in wide subcircular depressions, which thin out anteriorly. Posterior ambulacra more elongate, almost straight, subtending an acute angle.

Peristome excentric in front, semicircular.

Periproct elliptical, opening on the posterior extremity.

Fascioles?

This remarkable genus, which was established by Cotteau for the reception of two species—one from the Nummulitic strata of Biarritz and the other from Java, is especially characterized by the peculiar curvature of the anterior pair of petals, and by their position in wide, subcircular, shallow depressions or concavities of the test. A third species has subsequently been described by Dames from the neighbourhood of Verona.

The fossil from the Khirthar series of strata of Sind, which we are about to notice, accords in all points with the generic diagnosis defined by Cotteau, but unfortunately our example has suffered great damage from weather action, and the specific description which we are able to furnish is consequently in some respects imperfect.

1. BRISSOPATAGUS SINDENSIS, *Duncan & Sladen.* Plate XXXVIII, Figs. 19–21.

Test of medium size, elongate; marginal contour a subpyriform heart-shape, faintly indented anteriorly, the greatest breadth across a line lying in front of the centre, thence tapering considerably to the subrostrate posterior extremity. The greatest breadth is about four fifths of the length, or in the proportion of 0·79 : 1. Abactinal surface subdepressed, flatly convex, arching from the rather abruptly rounded margins. The odd posterior interradium is tumidly subcarinate, and the greatest height of the test lies at a point midway between the outer extremities of the posterior petals and vertically over the culminating point of the actinal plastron, the prominence of the latter greatly augmenting the measurement, the height being here proportional to the length as 0·45 : 1.

The apical disk is excentric in front, its distance from the anterior margin being about three eighths of the length of the test. All structure has entirely disappeared, the test being very thin, and this portion is unfortunately quite worn away.

The groove of the odd anterior ambulacrum is not defined until some distance away from the apical disk; it then gradually presents itself as a wide, shallow, depressed tract, which faintly, but distinctly, indents the anterior extremity, dying out just below the ambitus, and not being continued on the actinal surface; its floor appears to have been naked, or with very minute granulation. The anterior pair of petals are short, very widely divergent, of nearly uniform breadth throughout, and their course is conspicuously curved, forming a distinct arc with the convexity backwards; each petal is situated in a shallow subtriangular depression, or concavity of the test, which extends over more than half of the anterior interradium, thinning out gradually towards the front and the margin, and the deepest part being defined by the curved line of the petal. The poriferous zones are broad, nearly uniform in breadth throughout, and run parallel with one another; the pores are equal, transversely oval, wide apart, and united by an indistinct conjugating furrow; the divisional septa, which are comparatively broad, bore a few minute miliary granules in transverse line. The interporifeous area is of uniform breadth throughout, and is narrower than the distance of the pores apart in the poriferous zone. The posterior petals are longer than the anterior pair, are straight in their course from the apex towards the margin, and subtend an angle of about 42°; they are of almost uniform breadth throughout, which is equal to that of the anterior pair of petals; the poriferous zones, which are of uniform breadth throughout, run parallel to one another, and their structure is similar, and equal in all respects, to that of the anterior pair of petals. The posterior petals are situated in shallow depressions of the test, which extend and die out on the lateral interradia, and are perhaps somewhat less definite than those in which the anterior pair of petals are placed.

The anterior interradial areas appear tumid, or even with a tendency to become subcarinate in their anterior zone which intervenes between the odd anterior groove and the concavity of the test in which the antero-lateral petal is placed. The odd posterior interradium is decidedly tumid, forming a low, widely expanded subcarinate prominence along the median line, which slopes down to the depressed areas of the postero-lateral petals, and in the posterior portion down to the margin.

The peristome is rather small, bilabiate, with the posterior lip tumid, and its position is very excentric anteriorly.

The periproct is situate at the summit of the narrow posterior truncation, is comparatively large, and vertically subelliptical.

The actinal plastron develops a low angular carination along the median line, which reaches a culminating point at about two thirds of the distance from the peristome to the posterior extremity, and is thence faintly continued along this secondary or pseudo-subanal plastron, dying out entirely, however, at the rounding which takes place at the inferior margin of the posterior truncation. The secondary plastron is remarkable, and wholly actinal in position; on either side are included six or more pairs of ambulacral pores, from which may be inferred the former presence of a subanal fasciole, although no traces of such a band are discernible in our specimen. There appear to have been very broad naked areas corresponding to the postero-lateral ambulacral areas on either side of the plastron.

The ornamentation of the test is all more or less destroyed; that on the abactinal surface generally appears to have been small and homogeneous in character, whilst that of the actinal area consisted of larger and more isolated tubercles in large scrobicules, with a few minute miliary granules in the interspaces. Within the depressed areas, wherein the petaloid ambulacra are placed, there are the remains of a few very large primary tubercles, probably three or four in each, and no other similar ones are present elsewhere on the test.

In one of the lateral interradia there is a mark which occupies the probable position of a peripetalous fasciole, but whether such a structure was originally present we are quite unable to determine.

Remarks. Whilst the Indian form above described agrees in every particular with the generic diagnosis formulated by Cotteau for *Brissopatagus*, it differs considerably and unmistakably from each of the three species at present included therein. *B. Sindensis* is readily distinguished from *B. Caumonti*, Cotteau, by the more elongate and posteriorly tapering test, by the wide and more shallow anterior groove, and by the more elongate petals, as well as by the different ornamentation of the test. From *B. javanicus*, Cotteau, the shape of the test and the proportions and character of the ambulacra are alone sufficient to separate the Khirthar species. Finally, in *B. Beyrichi*, Dames, the form of the test and position and relative proportions of the anterior and posterior pairs of petals clearly indicate that the two species are undoubtedly distinct; although it seems probable that the Veronese form is the nearest ally of our Indian example. Dames defines a well-marked peripetalous fasciole in his form, but in the two species studied by Cotteau there is no indication of the presence of any fascioles; whilst in none of the three species has a subanal fasciole been observed. From the foregoing remarks it will be seen that *Brissopatagus Sindensis* may or may not have had a peripetalous fasciole, but that there is evidence, which almost amounts to confirmation, that a subanal fasciole was present.

Dimensions. Length of the test 39 millim., breadth 31 millim., height 17·5 millim.

Locality. In the Khirthar series of strata: Baili, west of Tóng. Survey-number $\frac{G\ 304}{25}$

Illustrations of the Species in Plate XXXVIII.

Fig. 19. Abactinal view of the test: natural size.
20. Actinal view of the test: natural size.
21. Longitudinal profile of the test: natural size.

Genus BREYNIA, *Desor*, 1847.

Large Urchins well characterized by the presence of peripetalous, internal, and subanal fascioles. There are large tubercles with deep scrobicules limited by the peripetalous fasciole, but not in the posterior interambulacrum. The internal fasciole crosses the four petals, and their pores within its area differ from those without and may disappear.

1. **BREYNIA CARINATA**, *d'Archiac & Haime.*

There is a single badly preserved, crushed, and almost unrecognizable specimen of this species included amongst the collection of Khirthar Echini from Sind, respecting which, however, we have grave doubts, on account of the nature of its matrix, as to the accuracy of its being referred to the Khirthar series of strata. The fossil probably belongs to a higher horizon, and was included in the collection under notice by mistake. As *Breynia carinata* occurs in higher beds in Sind, and is there found in a perfect state of preservation, we reserve any further remarks upon the species until a subsequent fasciculus, when dealing with the form from its authenticated horizon. We have previously noticed the species when describing the Echinoidea from Kachh. The present example is wholly unfitted for illustration, and almost worthless in a morphological point of view.

Locality. Accredited (probably by mistake) to the Khirthar series of strata. West side of Bhago-Thoro Hill, south of Sehwan. Survey-number $\frac{G\ 226}{96}$.

Genus MACROPNEUSTES, *Agassiz*, 1847.

Test of large or medium size, more or less inflated, cordiform; anteal sulcus scarcely perceptible, except at the ambitus.

Ambulacral summit subcentral or excentric in front. Apical disk compact; four generative plates, with the central madreporiform body narrow and elongate. Odd anterior ambulacrum different from the others, formed of simple and very small pores. Paired ambulacra petaloid, elongate, sometimes more or less excavated, the posterior pair usually rather longer than the anterior.

Peristome bilabiate, excentric in front.

Periproct at the summit of the posterior extremity.

Tubercles very unequal, the large ones isolated, prominent, and confined to the abactinal surface, the general tuberculation of the test being small and crowded.

One fasciole, peripetalous, which does not always limit the large tubercles.

1. **MACROPNEUSTES SPECIOSUS**, *Duncan & Sladen.* Plate XXXVIII, Figs. 1–5.

Test of large size. Marginal contour elongately oval, slightly indented anteriorly, rather more contracted and less fully rounded posteriorly. The greatest breadth is median, and is a little more than four fifths of the length, or in the proportion of 0·83 : 1. The abactinal surface is depressed, with its curvature regularly convex, springing from the comparatively thin, abruptly rounded margins, uniformly all round the test. The greatest height of the test is excentric posteriorly, but not to a very great degree; consequently when the low dorsal convex curve is seen in longitudinal profile the posterior slope is shorter and rather more inclined than the anterior; the greatest height is exactly two fifths of the length. The actinal surface is almost flat.

The apical system is excentric in front, its distance from the anterior margin being rather more than one third of the length, or in the proportion of 0·38 : 1. The four generative pores are rather closely placed, and the anterior and the posterior pair are equidistant. The odd anterior ocular plate is placed between the anterior generative plates, and is small. The lateral ocular plates are much larger and subpentagonal; the anterior pair are placed in the angle formed by the junction of the anterior and posterior generative plates, and the posterior pair are placed immediately behind the posterior generative plates, and are separated by the considerable posterior extension of the central madreporiform body. The ocular foramina are microscopic.

The odd anterior ambulacrum is straight or slightly flexuous in its course; and the anteal sulcus is not apparent until near the margin, increasing gradually in depth and breadth, and indenting the anterior extremity with a wide, but rather shallow, indentation, which terminates rather abruptly on the anterior interradia as seen from above. The poriferous zones are nearly parallel, and are composed of pairs of very minute pores obliquely placed, and rather wide apart from neighbouring pairs; the interporiferous area is flat, narrow, and of nearly uniform breadth throughout, excepting near the apex, and is ornamented with numerous definite and rather isolated miliary granules.

The anterior pair of petals are nominally flush with the surface of the test, although the depression of the poriferous zones in slight channels gives a rather prominent appearance to the interporiferous areas; they are very long, and extend close to the ambitus, widely divergent, subtending an angle of about 150°. Excepting at the proximal and distal extremities of the petals, the poriferous zones run parallel to one another. At the apical extremity the anterior zone of the petal converges gradually, forming a graceful curve; whilst the posterior zone is nearly straight in its course, its convergence being scarcely perceptible. At the outer extremity of the petal it is the posterior zone which converges, and forms the slight attenuation at the extremity, whilst the companion anterior zone remains straight. In this manner there is a slightly sigmoid character given to the petal, although its course, as a whole, might be said to be straight from the apex towards the margin. The poriferous zones are rather broad and of uniform breadth throughout, excepting at the extremities, where their attenuation emphasizes very largely the curved character above noticed; at the apical extremity 6 to 8 pairs of pores in each zone are so small as to appear almost aborted. The inner pores are transversely oval, and the outer to a much greater degree, almost appearing slit-like, and with a tendency to become pyriform; the pairs are united by a conjugating groove, and adjacent pairs are separated by thin well-defined divisional costæ ornamented with a single line of miliary granules. The interporiferous area is a little wider than the poriferous zone, and is ornamented with small definite and rather widely spaced miliary granules of two sizes, indiscriminately mixed, the whole having a very homogeneous appearance when seen with the naked eye. The posterior pair of petals are longer than the anterior pair, and like them extend nearly to the ambitus; their course is straight from the apex towards the margin, and they subtend an angle of about 47°. Their breadth is equal to that of the anterior pair, and their character and structure are similar, the terminal curvature, however, of the respective zones being less pronounced. The odd posterior interradium is distinctly tumid in its median portion.

The peristome is large, bilabiate, excentric in front, and to a greater degree than the apical system. The anterior margin is the arc of a transverse oval, and the posterior lip is prominent. A wide, but shallow groove is continued from the indentation of the anteal sulcus at the margin up to the peristome, in which the odd anterior ambulacrum is placed; and there is also a slight troughing near the peristome in the region of the antero-lateral ambulacral areas, the poriferous zones of these latter diverging slightly as they approach the aperture.

The periproct is very large, subcircular, and occupies the whole of the depth of the small vertical truncation of the posterior extremity.

The ornamentation is striking and greatly developed. It consists of two sizes of tubercles—one large and the other small. The large primary tubercles, which are perforate, crenulate, and placed in slightly sunken circular scrobicules, are confined to the abactinal surface, and are all within the bounds of the peripetalous fasciole; they stand on each of the interradial plates in a regular line parallel with the aboral margin of the plate, and consequently obtusely angulated; on the plates near the ambitus about a dozen are present, and the number decreases on successive plates as these latter diminish in width as they approach the apex. Each column of the interradia is thus furnished with a series of obtusely angulated lines of primary tubercles. On each plate, beneath the line of large primary tubercles, there are a number of very small tubercles, perforate and in small scrobicules; and the whole of the intermediate parts of the plate are occupied by small, uniform, miliary granulation rather distinctly spaced. At the ambitus and outside the latero-peripetalous fasciole and at the margin of the actinal surface the tuberculation is small and crowded. On the actinal surface proper the primary tubercles are large and well spaced, in slightly sunken scrobicules presenting frequently an upturned disk-margin at one side, the intermediate spaces being ornamented by very small, uniform, and closely placed miliary granules, of which there are seldom more than one series round the margin of each scrobicule, and with a few additional in the angular interspaces. The posterior ambulacral areas on either side of the actinal plastron are broad, and devoid of large primary tubercles, but closely covered with small granulation.

There is a very narrow, but distinct, latero-peripetalous fasciole encircling the ambitus, or only very slightly above, and consequently of the widest extent possible on the test, without encroaching on the actinal surface. No trace of a subanal fasciole is discernible; and furthermore the form of the test does not lead to the suspicion of such a structure having ever existed in the Spatangoid under notice.

Remarks. This handsome species is readily distinguished from all other Khirthar Spatangoids. Its facies, as determined by the numerous, prominent, and regularly arranged primary tubercles of the abactinal surface and the character of the ambulacral petals, is very unlike that of any *Euspatangus*; and on these grounds we have placed it in the genus *Macropneustes*, notwithstanding the fact that the preservation of our specimen unfortunately does not enable a positive observation to be made as to whether a subanal fasciole was present or not. The form of the test, however, in that region appears to preclude the supposition of its existence entirely.

Dimensions. Length of the test 70 millim., breadth 58·5 millim., height 28 millim., breadth of the postero-lateral petal 6·5 millim.

Localities. In the Khirthar series of strata:—i. Dháran pass, near Laki. Survey-number $\frac{G\,300}{2}$.

ii. Uncertain (purchased with others), said to be from Jakhmari, or from Teyón, Laki range. Survey-number $\frac{G\,302}{104}$.

iii. Uncertain (purchased), said to be near Jakhmari, Laki range. Survey-number $\frac{G\,304}{21}$.

iv. Said to be from near Jhirak (Jerruck) (presented), exact locality unknown. Survey-number $\frac{G\,280}{146}$.

Illustrations of the Species in Plate XXXVIII.

Fig. 1. Abactinal view of the test: natural size.
2. Longitudinal profile of the test: natural size.
3. The apical disk: magnified.
4. Portion of the odd anterior ambulacrum: magnified.
5. Portion of the antero-lateral ambulacrum: magnified.

2. MACROPNEUSTES ROTUNDUS, *Duncan & Sladen.* Plate XXXVIII, Figs. 6 & 7.

Test of medium size, depressed. Marginal contour rotundly oval or subcordiform, well rounded and very faintly indented anteriorly, more contracted posteriorly and broadly truncate. The greatest breadth is slightly excentric in front, and is proportional to the length as 0·9 : 1. The margins are well rounded and rather tumid. The abactinal surface is regularly convex, and, as far as can be ascertained from the specimen under notice, was probably highest posteriorly. The actinal surface has a slight tumid character in consequence of a little depression round the peristome and the well-rounded margins; the actinal plastron is also rather tumid.

The apical disk is excentric in front, its distance from the anterior margin being a little more than one third the length of the test. All details obscured. The anterior pair of petals are comparatively shorter than in the preceding species, and have a somewhat more petaloid appearance in consequence of the greater curvature of the posterior zone as compared with the anterior one. The poriferous zones, which are broad but diminish considerably at either extremity, are placed in shallow grooves of the test; the inner series of pores are elongately oval transversely, and the outer series slit-like, and united by a conjugating furrow. The interporiferous area is narrower than a poriferous zone, and appears to be slightly raised or tumid in consequence of the depressions in which the poriferous zones are placed; its ornamentation is obliterated. The anterior pair of petals are very widely divergent, and subtend an angle of about 160°. The odd anterior ambulacrum is scarcely discernible, and no groove is developed until close to the margin, where there is a wide but very shallow indentation of the test, which extends to the middle of the anterior column of the anterior interradia, along which there is, moreover, a faint, but distinctly perceptible, trace of carination. The pores are very minute and wide apart. The postero-lateral petals are unfortunately obscured.

The large tubercles of the abactinal surface are numerous, uniform, and prominent, and are arranged in lines parallel with the outline of the plates, and consequently obtusely angulated, as in the preceding species, the number, however, being less. There were also probably a few small tubercles amongst the miliary granulation of the plates, and it may be noticed that the tubercles generally diminish in size as they approach the margin. On the actinal surface the tubercles are large and distinct, and there is a tendency to assume a lineal arrangement in the lateral regions.

The latero-peripetalous fasciole is of wide extent, placed at the very margin of the test, just above the ambitus, in the anterior and lateral portions of the test; on the posterior half of the lateral interradia it leaves this extreme marginal position and encroaches on the abactinal surface slightly. Consequent on its marginal position the distance of the fasciole from the extremity of the antero-lateral petals is comparatively great. The fasciolar band is very narrow, and there do not appear to be any large tubercles outside its limits—a circumstance almost obviously dependent on its marginal position both in this and the preceding species. We can detect no trace of any subanal fasciole, and from the nature of the tuberculation that remains on the fragmentary portions of that region preserved in our specimen, we are led to infer that no fasciole was originally present.

Remarks. Notwithstanding the very bad state of preservation of the fossil under notice, and the consequent imperfection of the above description, the form is readily distinguishable from its associates, and, as far as we are aware, from the other species of the group. Owing to the uncertainty respecting the presence of a subanal fasciole, we felt some hesitation as to whether this form was really a *Macropneustes* or should instead be placed as a *Euspatangus*. The inferred absence of that structure, and the character of the abactinal tuberculation, determined our opinion in regarding it as belonging to the former genus, the primary tubercles being more numerous, more prominent, and in less definite scrobicules than are normally found in *Euspatangus*.

Dimensions. Length of the test 33 millim.; breadth 30 millim.; height, measured at the apical disk, 13·5 millim. (the greatest height is probably situated in the posterior interradium; but as that portion of the test is covered with matrix, no measurements are possible).

Locality. In the Khirthar series of strata. Teyón (or Tiyún), east of Chorla Survey-number $\frac{G\,302}{100}$.

Illustrations of the Species in Plate XXXVIII.

Fig. 6. Abactinal view of the test: natural size.
7. Actinal view of the test: natural size.

Genus PERIPNEUSTES, *Cotteau*, 1875.

Test of large or medium size, elongate, inflated, more or less cordiform. Anteal sulcus deep, deeply indenting the margin.

Ambulacral summit excentric in front. Apical disk compact, with four generative pores. Odd anterior ambulacrum different from the others, formed of small and simple pores. Paired ambulacra petaloid, narrow, very elongate, excavated, nearly equal in length, the posterior pair, however, being sometimes a little longer. Poriferous zones composed, on the apical portion, of small round pores, which become wider, subtransverse, and united by conjugating furrows as they recede from the apex.

Peristome bilabiate, excentric in front.

Periproct large, oval at the summit of the posterior extremity.

Tubercles of two kinds, one large, scrobiculate, isolated, confined within the boundary of the peripetalous fasciole, the general tuberculation of the test being crowded and homogeneous.

Two fascioles: peripetalous and subanal; the peripetalous fasciole being extensive, angular, and sinuous; the subanal annular.

1. Peripneustes, sp. Plate XXXVI, Figs. 18 & 19.

Two Spatangoid tests, the preservation of which is unfortunately so very unsatisfactory that even their generic determination is open to doubt, are referred by us to *Peripneustes*. They are characterized by the deeply indented anteal sulcus; by the long, narrow, paired ambulacra, placed in well-defined grooves; by the large, isolated primary tubercles confined to the interradia within the boundary of the peripetalous fasciole; and by the presence of a subanal fasciole. The poriferous zones in the left antero-lateral petal run nearly parallel, and the width of the interporiferous area is less than that of a poriferous zone. The larger primary tubercles within the peripetalous fasciole have small perforated mamelons, subconical bosses, deeply crenulate and large, circular, slightly sunken scrobicules. The size of the primary tubercles is irregular, that of the miliary granulation very small and uniform. The peripetalous fasciole is broad and well marked; it is sharply angulated in the anterior interradia, and is slightly incurved from a straight line between the extremities of the antero- and postero-lateral petals. The subanal fasciole appears to have been very large and probably subreniform in shape. The anteal sulcus is continued, from the ambitus on the actinal surface, up to the peristome, as a well-defined and rather narrow trough; and the posterior ambulacral regions which bound the actinal plastron are very broad and covered only with minute granulation. There is a faint gibbosity on each of the plates of the anterior interradia above the ambitus, and indications of a tendency towards a similar structure are discernible in the lateral interradia, but the character is much less developed there than in the anterior interradia.

As no other observations can be made on the specimens at our disposal, it is obvious that better material is needed before a specific diagnosis can be formulated. The two specimens are from different localities, but we believe that both belong to the same species; the best-preserved example has been drawn to facilitate future identification.

Dimensions. Length of the test about 58 millim., breath about 50 millim., height about 30 millim.

Localities. In the Khirthar series of strata:—i. Dháran pass (east side), near Laki. Survey-number $\frac{G\,280}{66}$.

ii. Picked up on the east side of the Shúm valley, east of Damaj. Survey-number $\frac{G\,236}{86}$.

Illustrations of the Species in Plate XXXVI.

Fig. 18. Abactinal view of the test: natural size.
19. Longitudinal profile of the test: natural size.

Genus EUSPATANGUS, *Agassiz*, 1847.

Test of medium size, elongate, heart-shaped, generally depressed. Anteal sulcus feebly developed.

Ambulacral summit usually more or less excentric. Apical disk compact; four generative plates, with the central madreporiform body produced posteriorly. Odd anterior ambulacrum different from the others, very insignificant, with small widely spaced pairs of pores. Paired ambulacra petaloid, usually more or less wide, closed at the extremity, not excavated. Poriferous zones broad, equal, less than the width of the interporiferous area, the external series of pores pyriform, the internal round.

Peristome bilabiate, excentric in front.

Periproct at the summit of the posterior extremity.

Tubercles of two kinds—one large, mammillated, perforate, crenulate, in scrobicules, standing isolate and more or less widely spaced on the anterior and lateral interradia, within the boundary of the peripetalous fasciole; the general tuberculation of the test being small and accompanied by numerous very small miliary granules.

Two fascioles—peripetalous and subanal; the peripetalous fasciole circumscribing the ambulacral petals, the subanal more or less cordiform or reniform.

1. Euspatangus avellana, *d'Archiac & Haime.* Plate XXXVIII, Figs. 8–13.

Brissus? avellana, *d'Archiac* (1850), *Hist. des progrès de la Géol.* t. iii. p. 251.
Eupatagus? avellana, *d'Archiac & Haime* (1853), *Descrip. An. foss. de l'Inde*, p. 218, pl. xv, fig. 8 *a*, *b*.

The following is the diagnosis of this species given by MM. d'Archiac and Haime:—

Body oval, elongate, thick; the four genital pores large and closely placed. Ambulacral plates rather narrow, tolerably well closed, the posterior longest and straight, the lateral feebly arched in front; poriferous zones moderately broad, costulate, with very large pores; odd ambulacrum very indistinct, and simply indicated in front by a very slight concavity. Anterior interambulacral areas a little broader than the lateral, which are themselves a little more than the odd posterior; all exhibiting large tubercles situated in slightly excavated scrobicules, which are interspersed with smaller tubercles and with unequal granules. All the tubercles cease near the ambitus, where a peripetalous fasciole probably existed, but which it has been impossible for us [*d'A. & H.*] to verify. The anus is marginal and rather in the upper part; the periproct suboval and a little longer than wide. The under surface of the body is feebly convex and covered with slightly prominent tubercles, interspersed with small granules, which increase in size from the margin inwards; the mouth is situated at the anterior third of the major diameter. The single example which we [*d'A. & H.*] have observed measured 16 millim. in length, and 9 millim. in breadth and height.

The type above referred to is in the collection of the Geological Society of London; it is small and much rubbed, and scarcely represents the character of the adult form.

The large series of examples obtained from the Khirthar strata in Sind enable us to add several observations to the foregoing description. The peripetalous fasciole, whose presence was inferred by d'Archiac and Haime, is always present, but is frequently untraceable in badly preserved specimens on account of the extreme narrowness of the band; it is of wide extent, oval in shape, non-sinuous, encircles the abactinal surface, passing near to the extremities of the ambulacral petals, and consequently not far above the ambitus; in fact, anteriorly, it is actually coincident with the ambitus. In addition to the peripetalous fasciole there is a remarkably well-defined subanal fasciole, of which no mention is made by d'Archiac and Haime. The band is broad and subcordiform in shape, defining a rather tumid and longitudinally subcarinate subanal plastron, the transverse diameter of which is only a little greater than the longitudinal. About five pairs of pores are included on either side of the area, and the associated granulation is very regular in arrangement,—shallow furrows radiating from each of the pairs of pores towards the centre of the plastron, and the intermediate spaces being ornamented with a row of primary tubercles, which increase gradually in size as they recede from the fasciole, the rows being further marked out by a companion row of small uniform miliary granules. This plastron has the appearance of being divided into two areas by a narrow semicircular naked band, which limits the rows of tubercles above mentioned; and the ornamentation within the subcrescentic area lying between this band and the adoral margin of the fasciole consists of rows of tubercles radiating towards the anus and diminishing rapidly in size as they approach the fasciole. In this manner a very ornate character is given to the subanal plastron.

The actinal plastron is very remarkable; it is subcarinate, and terminates posteriorly in a sharp and very prominent peak or culminating point, whilst the profile-outline of the longitudinal keel is incurved between this point and the peristome; the tuberculated portion of the plastron is very small in consequence of the wide naked posterior ambulacral areas, and the tubercles diminish in size in its neighbourhood. There is some depression around the peristome, and the surrounding test has consequently a rather tumid character.

In large adult tests the odd posterior interradium on the abactinal surface is tumid and roundly carinate, forming a more or less elevated keel between the posterior pair of petals, as shown in Figs. 10 & 11; but this character is not developed in small tests.

There is a good deal of variation in the length, and consequently in the marginal contour of this species, some examples, which are usually young, being much more elongate than others, which are more regularly oval. There is a single specimen of a wide well-rounded form (with survey-number $\frac{G\,236}{100}$), which perhaps shows this in a greater degree than usual; we do not, however, see any reason to recognize it as a nominal variety.

Remarks. The general facies of this species is very unlike that of typical *Euspatangi*, and we can fully appreciate the doubt expressed by d'Archiac and Haime when referring their single, small, and poorly preserved specimen to that genus. The character of the tuberculation and the form of the test are in much closer accord with *Macropneustes*, and we should have so placed it with very little hesitation, were it not for the presence of the well-developed subanal fasciole. We cannot dispel the impression that the differences which at present separate *Macropneustes*, *Euspatangus*, and *Peripneustes* are exceedingly artificial; and although we are by no means prepared to admit the desirability of uniting all the forms comprised within these three divisions under one genus, we are far from being satisfied with their present distinction by means of empirical adherence to a specific formula based on one or two characters only. A larger series of better-preserved specimens of the various species in each of the groups named than at present exists, is necessary before the question can be approached with much prospect of success.

A form whose general facies bears much resemblance to the Sindian species was described and figured by de Loriol, under the name of *Macropneustes Lefebvrei*, in his Monograph on the Nummulitic Echini from Egypt*; better-preserved specimens are again figured and described in his recently published work on the Eocene Echinoidea from Egypt and the Libyan Desert†. The only bar to the generic alliance of the two species appears to be the presence of the subanal fasciole. The absence of the subanal fasciole in *M. Lefebvrei* is especially remarked upon by M. de Loriol, who also observes that its presence would place the species in *Euspatangus*. *Euspatangus avellana* might well be taken as the fulfilment of the supposition in point. In the drawing given of the Lybian example of *M. Lefebvrei* there appears to be a tantalizing naked band shown by the artist in *op. cit.* pl. xi. fig. 2 *d*, which simulates a fasciole in a remarkable manner, both in outline and position.

Dimensions.

	a. millim.	*b.* millim.	*c.* millim.	*d.* millim.	*e.* millim.	*f.* millim.
Length of the test . .	38	32	21	21·5	12	11
Breadth of the test .	32·5	27	17	18·5	10·5	10
Height of the test . .	22	19·5	11·5	11·25	8	5·75

Localities. In the Khirthar series of strata:—

i. Karra range, south of Trak. Survey-number $\frac{G\,302}{125}$.

ii. Gágar hill, east side of the Súrjána range. Survey-number $\frac{G\,302}{114}$.

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* *Op. cit.* p. 75, pl. ix. figs. 7–9.

† *Op. cit.* p. 50, pl. xi. figs. 2, 3.

iii. Three miles east of Búla-Khán. Survey-number $\frac{G\,302}{112}$.

iv. Mairi valley, south of Teyón. Survey-number $\frac{G\,302}{101}$.

v. Teyón (or Tiyún), east of Chorla. Survey-number $\frac{G\,302}{100}$.

vi. North of Maliri, sixteen miles south of Jhángára (from shales and marly beds of upper part of the group). Survey-number $\frac{G\,302}{99}$.

vii. Exact locality not known (presented), said to be near Kotri, probably the hills west of Kotri. Survey-number $\frac{G\,280}{144}$.

viii. Keúhír-ka-lak (pass), east side of Súrjána range. Survey-number $\frac{G\,280}{74}$.

ix. Eight or nine miles south by west of Jangri, and east of the Súrjána range. Survey-number $\frac{G\,280}{73}$.

x. Twenty-four miles west of Kotri (entering the hills on the road to Búla Khán's Thána). Survey-number $\frac{G\,280}{72}$.

xi. Dháran pass (east side), near Laki. Survey-number $\frac{G\,280}{66}$.

xii. West side of the Ganja hills, south of Hyderabad. Survey-number $\frac{G\,226}{160}$.

xiii. About seven miles north-east of Búla Khán's Thána. Survey-number $\frac{G\,226}{113}$.

xiv. Near the gorge of the Báran river, north-east of Búla Khán. Survey-number $\frac{G\,226}{100}$.

Illustrations of the Species in Plate XXXVIII.

Fig. 8. Abactinal view of the test: natural size.
9. Actinal view of the test: natural size.
10. Transverse profile of the test, seen from behind: natural size.
11. Longitudinal profile of the test: natural size.
12. The peristome and surrounding portions of the test: magnified.
13. The apical disk, the odd anterior ambulacrum, and the right antero-lateral petal: magnified.

2. EUSPATANGUS CORDIFORMIS, *Duncan & Sladen*. Plate XXXVIII, Fig. 14.

Test of large size. Marginal contour elongate, heart-shaped, well and widely indented anteriorly, rather sharply flattened in the anterior interradia, contracting towards the posterior extremity, which is broadly truncate. The breadth is about nine tenths of the length, or in the proportion of 0·89 : 1. The abactinal surface is much depressed and is comparatively flat, excepting a slight tumidity in the interradial areas. The greatest height, which is equal to about one third of the length, lies near the posterior extremity of the test, and the slope thence to the anterior extremity is a very slight decline. The margins are thick and tumid. The actinal surface is more or less flat or very faintly convex, mainly consequent on the gradual passage into the marginal rounding.

The apical disk is excentric in front, but is unfortunately obscured. The odd anterior ambulacrum is scarcely discernible; it is flush with the test near the apex, the groove being developed only near the margin, and the pores are quite microscopic. The antero-lateral petals are long and widely divergent, and scarcely so petaloid as frequent in this genus. Their course has a slightly sigmoid tendency, with a slight curve forwards at the outer extremity, the flexure of the posterior zone of the petal being much greater than that of the anterior zone. The postero-lateral petals are longer than the anterior pair and a shade broader; they are rather widely divergent for posterior petals, and have also a slight sigmoid curvature. Excepting at the apical extremity, where the convergence is great, and the petal is very attenuated, the zones to a certain extent have the appearance of running parallel to one another, the posterior zone curving, however, conspicuously towards its companion at the outer extremity. The poriferous zones are broad in the anterior and posterior petals alike; the pores are transversely oval, wide apart, and connected by a conjugating furrow, and the divisional septa are ornamented with a single line of minute miliary granules. The interporiferous area is equal in width to the poriferous zone midway between the extremities, and appears to have been ornamented with a few widely spaced miliary granules with a rather larger one than the rest opposite each of the divisional septa, and sometimes two. The areas of the paired ambulacral petals are slightly sunken in shallow, widely expanded, depressions of the test, which are so wide and shallow that they are in no sense grooves; and their presence imparts a certain appearance of tumidity to the interradial areas.

The large primary tubercles within the fasciole on the abactinal surface are rather numerous, prominent, and on conical bosses; they are unequal in size, the largest being near to the margin of the petal, and they do not present the appearance of definite arrangement very conspicuously; their mamelons are very small and perforate, and the crenulation is distinct; the scrobicules are large, circular, and very slightly sunken; and the intervening portions of the plates are occupied with a minute but definite miliary granulation, amongst which a few very small perforated tubercles are placed. In the neighbourhood of the margin the perforated tubercles are small, uniform, regular, and numerous, and their scrobicules are separated only by a single circlet of very small miliary granules, and even this is sometimes incomplete. On the actinal surface the primary tubercles are large, and though apparently well spaced, there were probably very few miliary granules present in consequence of the crowding and overlapping of the large disk-like scrobicules, one margin of which is more or less prominent.

Both peristome and periproct unfortunately are destroyed; the position of the former was very excentric in front, and there appears rather considerable depression around the anterior margin of the aperture, and especially defined in the three anterior ambulacral areas.

The peripetalous fasciole is a very narrow band, running close to the outer margin of the abactinal surface, and only a little above the ambitus on the anterior half of the test; in the posterior column of the lateral interradia it gradually leaves the margin and encroaches more on the abactinal surface, passing close to the extremity of the postero-lateral petals. The structure of the fasciole is exceedingly delicate, and its course is well marked out on either side by series of minute uniform miliary granules. Although nearly the whole of the posterior extremity is destroyed in our specimen, a portion still remains of a very large and broad subanal fasciole. It was probably widely subreniform in shape, and the breadth of the band is much greater than that of the peripetalous one.

Remarks. This species is well distinguished from all its congeners, and cannot be mistaken for any *Euspatangus* with which we are acquainted. The long, narrow, ambulacral petals and the comparatively prominent and shallow-scrobiculed large primary tubercles are strongly suggestive of features in *Macropneustes.* The test, however, is very depressed, the primary tubercles are clearly limited by the peripetalous fasciole, and a wide and well-developed subanal fasciole is present,—characters which in the present state of our knowledge justify us in referring the species to *Euspatangus.*

Dimensions. Length of the test 65 millim., breadth 58 millim., height about 21·5 millim.

Locality. In the Khirthar series of strata: Dháran pass (east side), near Laki. Survey-number $\frac{G\,280}{66}$.

Illustration of the Species in Plate XXXVIII.

Fig. 14. Abactinal view of the test: natural size.

3. Euspatangus rostratus, *d'Archiac.* Plate XXXVIII, Figs. 15–18.

We have already remarked upon the type specimens of this species when describing the fossil Echinoidea of Kachh, and also upon the examples which are found in that collection.

The following is the diagnosis given by MM. d'Archiac and Haime:—

Body elongate, suboval; subbilobed in front, rather attenuated behind, and truncated at the extremity; tolerably depressed, rather thickened behind. Ambulacral petals tolerably well closed, rather sharp-pointed, moderately broad, and rather long. Poriferous zones rather narrow, costulate. Anterior ambulacrum only slightly depressed in front, with indistinct pores. The lateral interradia are broader than the anterior, and the posterior is narrow and swollen behind; it is smooth like the ambulacra, but the others are covered with large tubercles unequal in size, and sunken in shallow scrobicules. The peripetalous fasciole appears to be submarginal.

The periproct is marginal, suboval, and angular above, higher than broad. Inferior aspect nearly plane, but swollen in front of the anus along the median line.

The peristome is at the anterior two sevenths of the major axis. Good-sized tubercles are on the lateral interradia.

To this diagnosis we have added (*op. cit.* p. 48):—The inner pores of the anterior poriferous zone of the antero-lateral ambulacra abort; the madreporic body extends far back and separates the posterior ocular pores; the subanal fasciole is distinct; the plastron is large and wide; the great tubercles are crenulated slightly.

We have also stated that in the examples of this species from Kachh no indications of the peripetalous fasciole were discernible; in the specimens from the Khirthar series of strata in Sind we have, however, been more fortunate, and find in several instances traces of this fasciole; it is, however, the most feebly developed fasciole we have seen, and is not more than two or three rows of minute granules in width, and we have in no case assured ourselves that it is continuous; the traces observed are entirely on the abactinal surface, and do not support the supposition of d'Archiac and Haime that the peripetalous fasciole was submarginal. The few Khirthar specimens are all more or less badly preserved, and they accord closely with the type of the species.

Dimensions. The largest specimen measures 30 millim. in length and 24 millim. in breadth; all are somewhat crushed.

Locality. In the Khirthar series of strata: Karra range, south of Trak. Survey-number $\frac{G\,302}{125}$.

Illustrations of the Species in Plate XXXVIII.

Fig. 15. Abactinal view of the test: natural size.
16. Actinal view of the test: natural size.
17. Longitudinal profile of the test: natural size.
18. Portion of a lateral ambulacrum to show ornamentation: magnified.

GENUS INDET.

GEN. et SP. INDET. Plate XXXIV, Fig. 17.

There is a fragmentary test of a large Spatangoid in the collection which baffles all attempts at determination on account of its very bad state of preservation. From the few guiding features that are observable we are inclined to think that this very unsatisfactory fossil represents a new genus, the systematic position of which would probably be under the subsection *Brissina*. The specimen has been drawn on Plate XXXIV, Fig. 17, and a reference thereto will give a much better idea of the fossil than any verbal description. The chief notable point is the character of the ambulacra, all of which are situated in deep, sharply-defined grooves, those of the paired petals being of equal breadth throughout, excepting close to the apex, and appearing to extend to the margin. The antero-lateral petals are nearly horizontal. The odd anterior ambulacrum is situated in a wider and even deeper groove than the others, which forms at the ambitus a deep, sharply defined notch. A few pairs of pores at the apical extremity of some of the poriferous zones may be seen, the inner series of pores are transversely oval, and the outer series are still more elongate transversely, and with a tendency to become pyriform; the pores of a pair are moderately well spaced, and are united by an indistinct conjugating furrow, and the divisional septa, in this part at least, are not keeled. The abactinal surface was not very high, but slightly subconically convex, springing with an arch from probably thin, abruptly rounded, margins,—the actinal surface being apparently more or less plane. From an indication which remains near the margin, the ornamentation in that region appears to have consisted of moderate-sized primary tubercles on circular disk-like scrobicules, all equal sized, and so closely placed that only one or two isolated miliary granules are present here and there.

Unfortunately no further observations are possible on this very interesting fossil, and under such circumstances we are obviously unable either to formulate a generic diagnosis, or even to draw any useful comparisons with other known forms of Spatangoids.

The length of the fragment, which is incomplete, measures about 75 millim.

Locality. In the Khirthar series of strata: Roïs Hill, near Damaj, south of Búla Khán. Survey-number $\frac{G\,302}{119}$.

Illustration of the Specimen in Plate XXXIV.

Fig. 17. Abactinal view of the test: natural size.

IV. *Remarks on the Genera and Species of the Khirthar Series.*

Seventy species and varieties (including 3 doubtful forms evidently placed by mistake in this collection) have been described in the preceding pages.

The number of species of regular Echini is remarkably small, six only, belonging to five genera, being recorded. One of these, the *Temnechinus Rousseaui*, appears to us to have been unquestionably included accidentally, and should consequently be excluded from the Khirthar fauna; this leaves five species of regular Echini in the Khirthar series, representing a numerical proportion of only 7·46 per cent. in relation to the irregular forms, the latter being 62 in number when the 2 doubtful species are excluded. This shows a very striking difference when compared with the underlying Ranikot fauna, in which the proportion of regular forms stands at the high figure of 42·85 per cent.

The predominant form of regular Echini, as far as may be judged from the number of specimens in the collection, is a species of *Micropsis* of small habit, having structural alliances to the *M. Mokattanensis* from Egypt, and of which it is probably the Indian representative. The form has also much resemblance to *Cyphosoma superbum* from San Giovanni Ilarione; the differences which separate the two species generically being of the most trivial character.

Of true *Cyphosoma* there are two well-marked species, one of them being probably nearly allied to the form erroneously referred by d'Archiac and Haime to the genus *Echinometra*, under the name of *E. Thomsoni*; both are comparatively weakly developed forms, of the type in consequence of the small size of the tubercles and the simple ambulacra.

The *Cidaris* (*Leiocidaris*) is closely allied to *C. Verneuili* of the Ranikot series, of which it is probably the descendant. It is, however, specifically distinct.

The *Porocidaris* is more nearly related to the recent forms than to *P. serrata*, which occurs in the Egyptian and Swiss Nummulitic beds. The pits in the scrobicules are comparatively feebly developed, and, as in the recent forms, do not perforate the test. It was suggested by Sir Wyville Thomson that the fact of their doing so in the case of *P. serrata* might probably be owing to wearing and attrition during the process of fossilization, an opinion which we are fully disposed to endorse.

The 62 undoubted Khirthar forms of irregular Echini belong to 20 genera. The presence of *Amblypygus*, *Echinolampas*, *Brissopsis*, *Metalia*, *Macropneustes*, and *Euspatangus* imparts a strikingly marked and characteristic facies to the fauna.

The genus *Conoclypeus* is represented by four well-marked species, and the only other gnathostomatous exocycloid Echinoids in the collection are the diminutive genera *Sismondia* and *Echinocyamus*, the Khirthar species of which exhibit an extraordinary amount of variability.

The Cassidulidæ are present in great force. Of *Amblypygus* there are four species, one of which serves well as the representative of the European *A. dilatatus*. From the series of specimens at our disposal we have been enabled to study the structural peculiarities of the genus, and have indicated that its association with the *Echinoneinæ* becomes necessary.

The interesting little forms to which we first gave the name of *Eolampas* in the Ranikot series, where they appeared to stand as the forerunners of the genus *Echinolampas*, are represented by a distinct species in the Khirthar strata.

The genus *Echinolampas* now becomes a dominant form, and no less than eleven distinct species and a variety are recorded in the preceding pages. All of these, as a whole, have a decided and characteristic facies distinguished by the comparatively low test and the usually narrow and slightly expanded ambulacral petals. One of the species presents features which show close alliance to *E. discoideus*, and another has affinities with the forms of which *E. Escheri* and *E. subcylindricus* are the representatives; a third is very nearly related to the *E. silensis* of the Swiss Nummulitic strata, and this species shows perhaps a closer alliance to the European form than any other Khirthar Echinoid. There is also a form, represented only by a single example, which is very near to *E. Jacquemonti*, an abundant species in a higher horizon.

Echinanthus is represented by a very unsatisfactory specimen; but its near ally *Ilarionia* occurs plentifully. The Indian species of the latter genus shows considerable variation in form, and the characters upon which the genus was established are also somewhat modified.

The single species of *Cassidulus* is distinct from, but representative of, the species in the Ranikot series.

Rhynchopygus is a common form in the Khirthar strata, and its two species here take the place of *Eurhodia*, which is characteristic of the Ranikot beds. The small species *R. pygmæus*, which was noticed in the description of the Ranikot Echini, was probably included in that collection by mistake; and the evidence upon which this assumption is based will be referred to presently. The species is numerously represented in the Khirthar series.

One of the most interesting forms in the collection has been referred by us to the genus *Micraster*, although its form is more or less abnormal in comparison with the general character of that group, the test being high, tumid, subglobose, and very slightly indented by the anteal sulcus; its structural details, however, appear, as far as we have been able to study them from the material at our disposal, to accord with the formula of *Micraster* in such a manner as to warrant the inclusion of the Khirthar specimens in that genus. There is no form at present known to us in the underlying Tertiary beds in Sind which represents this interesting species, or serves to connect it with Cretaceous forms.

Hemiaster is well represented in the Khirthar series; the most numerous species, however, being the dwarf or pony-like form *H. digonus*, which is very abundant in the white limestone. Seven species of this genus occur in the collection; but of these, three are in such a bad state of preservation as to preclude any specific diagnosis being given. Further material is consequently necessary before a satisfactory estimate of this genus in the Khirthar series can be furnished.

Brissopsis is represented by a well-marked, characteristic, and moderately abundant species, the nearest alliances of the form lying perhaps in the direction of *B. Jimenoi*, described by Cotteau from the Miocene of Cuba.

The genus *Metalia* is an eminently characteristic and abundant Khirthar form, six species and a variety being defined in the preceding pages. Some of the species were obtained from a great number of localities, and considerable variation in form is noticed.

The single species of *Linthia* is a very handsome and well-marked form. On the other hand, the genus *Schizaster* is poorly represented; and, although four species are observed, the individuals are small in number and badly preserved; furthermore, with the exception of *S. baluchistanensis*, the forms here referred to the genus very feebly present the normal *Schizaster* facies.

An interesting example of *Brissopatagus* occurs in the collection, which exhibits all the characters of the genus, but differs considerably from the other known species of this singular form.

Macropneustes is represented by two species, which to a certain extent have a peculiar Euspatangoid facies, and one of these was found in several localities.

Of *Euspatangus* three species occur in the Khirthar series, and, with the exception of *E. rostratus*, which also occurs in higher measures, these forms, strange to say, present a striking Macropneustoid facies; the commonest species, which is also one of the most abundant forms in the collection, *E. avellana*, resembles very closely in general character *Macropneustes Lefebvrei*, de Loriol, from the Nummulitic strata of Egypt, of which we consider it to be the representative in the Sindian area, notwithstanding the questionable generic differences.

Three forms, represented only by single fragmentary examples, have evidently, from the character of their matrix and fossilization, been included by accident in the Khirthar collection; these are *Temnechinus Rousseaui*, *Breynia carinata*, and *Moira primæva*. The two former have already been noticed by us from the Miocene strata of Kachh and Kattywar; and they also occur in corresponding beds in Sind. The *Moira* appears to be a distinct species from the common Miocene form of Kachh, and it is unfortunate that the true locality of this example is unknown.

Mention should here be made of four characteristic Khirthar forms which were included in the collection of Echinoidea from the Ranikot series of Sind, and referred to in Part II. of this work. The evidence respecting the examples in question is very strong against their belonging to the Ranikot series at all, and until further confirmation is forthcoming we do not feel justified in counting them as members of that fauna, or in basing such generalizations upon their presence as their recognition as Ranikot species would obviously demand. The forms referred to are *Rhynchopygus Calderi*, *Rhynchopygus pygmæus*, *Hemiaster digonus*, and *Metalia Sowerbyi*; and the following facts respecting them are very significant. In each case the forms were represented only by solitary and very badly preserved specimens, excepting *R. pygmæus*, of which there were two or three. All the examples of these four species in the Ranikot collection were from one locality, viz. N.E. of Petiáni. On referring to the memoir on the Geology of Western Sind by Mr. W. T. Blanford, F.R.S. [*], we find it mentioned that two outliers occur north-east of Petiáni, the age of which is not clearly determined; and the resemblance of the rock, in one of them at least, to a sandstone occurring at Jungsháhi, age also not clearly determined, is remarked on (*op. cit.* p. 146).

In reference to this question, it is of interest to note incidentally that two of the four species above cited have been found at Jungsháhi, in strata of the Khirthar series, at the localities numbered by the Surveyors $\frac{G\ 280}{118}$ and $\frac{G\ 280}{117}$.

If it were the case that the doubtful specimens under notice were obtained from the outliers mentioned by Mr. Blanford, it might be inferred, on the palæontological evidence, that the outliers were of Khirthar age; and in the event of these specimens having been picked up on the surface, which would appear very probable from their weathered condition, we are still of opinion that they were derived from Khirthar beds [†].

From the foregoing summary it will be seen that not a single species is common to the Khirthar and Ranikot strata, if the doubtful forms above referred to are excluded from the list.

Attention has already been drawn to the specialized and well-marked character of the Khirthar fauna as compared with that of the Ranikot; and this becomes still more patent and conspicuous when the lists of genera contained in the respective measures are placed side by side. Excluding the doubtful forms previously mentioned, the Ranikot fauna comprises 24 genera of Echini and that of the Khirthar 25 genera; of these only 9 genera are common to the two series of strata. It will thus be seen that the Khirthar fauna is a remarkably isolated assemblage of forms in relation to the underlying fauna of its own area.

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[*] Mem. Geol. Surv. India, vol. xvii.

[†] Mr. Blanford, with whom we have corresponded on the subject, is fully disposed to concur in this latter supposition. He also informs us that at a locality about 20 miles further south he was enabled to draw a line at the base of the Khirthar beds, and to separate them from the Ranikot, on account of the presence of *Rhynchopygus Calderi* in the former—a species which, in his experience, is characteristic of a zone at the base of the Khirthar. In the locality mentioned the two groups could only be distinguished by fossils, the mineral character being similar. If, as is probable, there is the same similarity north-east of Petiáni, it can easily be imagined that fossils might have been obtained from supposed Ranikot beds, which were really of Khirthar age.

The Khirthar fauna, when viewed with respect to its homotaxial relations, is not less remarkable. The Nummulitic horizon of Egypt and Lybia, with which comparison may most suitably be instituted, presents an Echinifauna of 61 species, described by de Loriol; and of these none are common to the two areas. The generic constitution of the faunæ, however, shows an unmistakable homotaxial relationship, as out of 22 genera represented in the Egypto-Lybian area (compared with 25 genera in the Khirthar series of Sind), 16 genera are found to be in common.

A similar generic affinity will be found to exist when the Khirthar Echini are compared with those of the different European Nummulitic areas; but in no instance can a case of specific identity be established.

The forms which may be considered as representatives of species occurring in the various Nummulitic areas of Europe have been indicated in the preceding pages.

V. *Note on doubtful Khirthar Species.*

We again draw attention, for the sake of caution, to the three forms included in the present collection, but which we do not consider to belong to the Khirthar horizon. These are:—

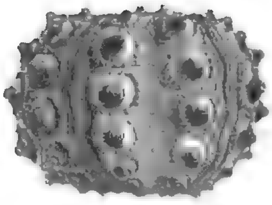
Temnechinus Rousseaui, d'Archiac, sp.
Moira primæva, Duncan & Sladen.
Breynia carinata, d'Archiac & Haime.

In each case the species is represented only by a single, badly preserved, fragmentary example, and the matrix is altogether different from that of the other Echinoids from the Khirthar series of strata. There seems little doubt that these specimens have been included in this collection by mistake, and were probably marked by accident as coming from the localities to which they are respectively assigned.

PLATE XXI.

Figure 1. Leiocidaris canaliculata, Duncan and Sladen (page 109). The test seen in profile, natural size.

2. Actinal view of a part of the test, natural size.
3. Plates of the interambulacral area, magnified.
4. Ambulacral plates, a little above the ambitus, magnified.
5. Ambulacral plates from a larger specimen, at the ambitus, magnified.
6. Ideal section of an ambulacral area.
7. A portion of a spine, magnified.
8. A young specimen, seen in profile, magnified.
9. Ambulacral plates from the same, magnified.
10. Porocidaris anomala, Duncan and Sladen (page 113). The test seen in profile, natural size.
11. Actinal view of a part of the test, natural size.
12. An interambulacral plate with the adjacent portion of the ambulacral area, magnified. (The scrobicule ought to be more distinctly oval transversely than represented in this figure, or in Figure 10.)
13. Ambulacral plates, magnified.
14. Outline of a fragment of a spine, slightly magnified.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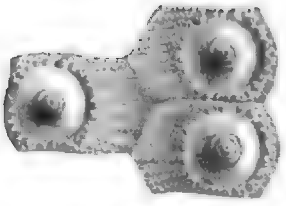
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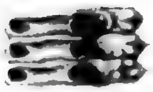
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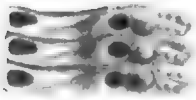
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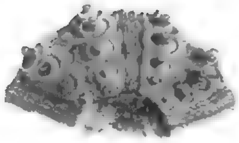
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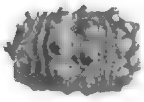
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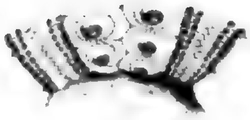
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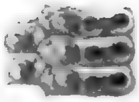
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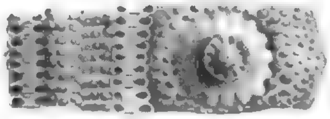
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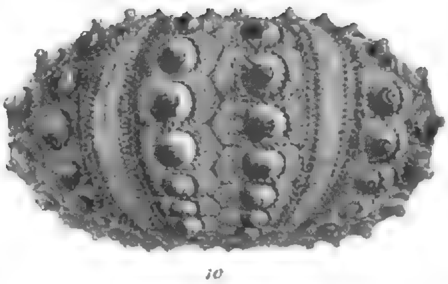
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Duncan & Sladen dir. A. S. Ford lith.

Mintern Bros imp.

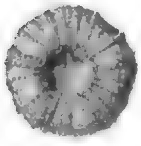
Fossil Echinoidea from Sind.
Khirthar Series.

PLATE XXII.

Figure 1. Micropsis venustula, Duncan and Sladen (page 119). Profile view of the test, magnified × 2.

2. Abactinal view of the test, natural size.
3. Actinal view of the test, showing peristome, natural size.
4. Abactinal view of the test of a pentagonal variety, natural size.
5. Apical disk, magnified × 7.
6. Ambulacral and interambulacral plates, magnified.
7. Diagram of the poriferous plates of the ambulacral plate.
8. Cyphosoma macrostoma, Duncan and Sladen (page 116). Profile view of the test, natural size.
9. Actinal view of the test showing peristome, natural size.
10. Ambulacral and interambulacral plates, magnified.
11. Cyphosoma undatum, Duncan and Sladen (page 117). Outline of the profile contour of the test, natural size.
12. Ambulacral and interambulacral plates, magnified.
13. Temnechinus Rousseaui, d'Archiac, sp. (page 122) *. Profile view of the test, magnified × 2.
14. Ambulacral and interambulacral plates, magnified.

* This species is probably included by accident in the Khirthar series.



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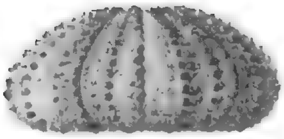

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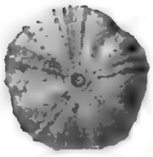

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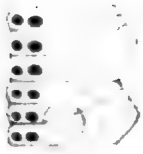

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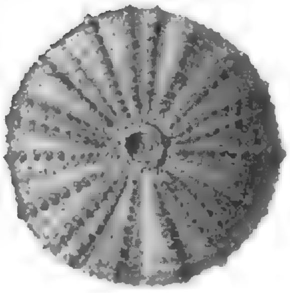

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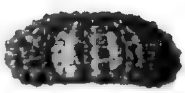

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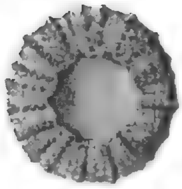

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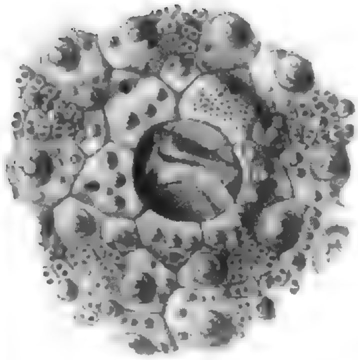

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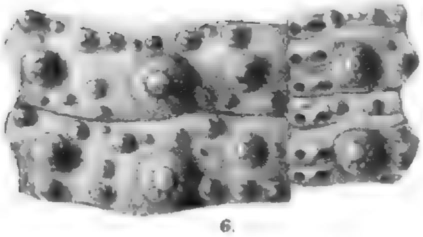

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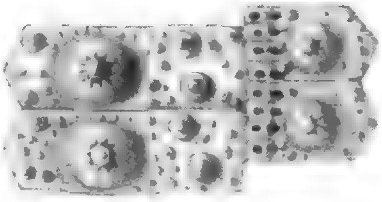

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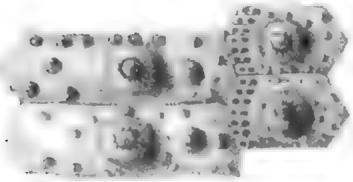

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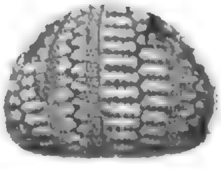

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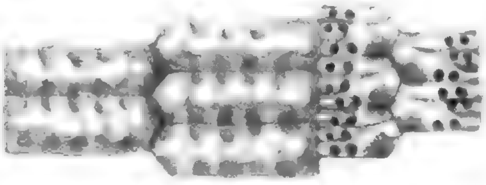

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Duncan & Sladen del. A.S. Foord lith.

Mintern Bros imp.

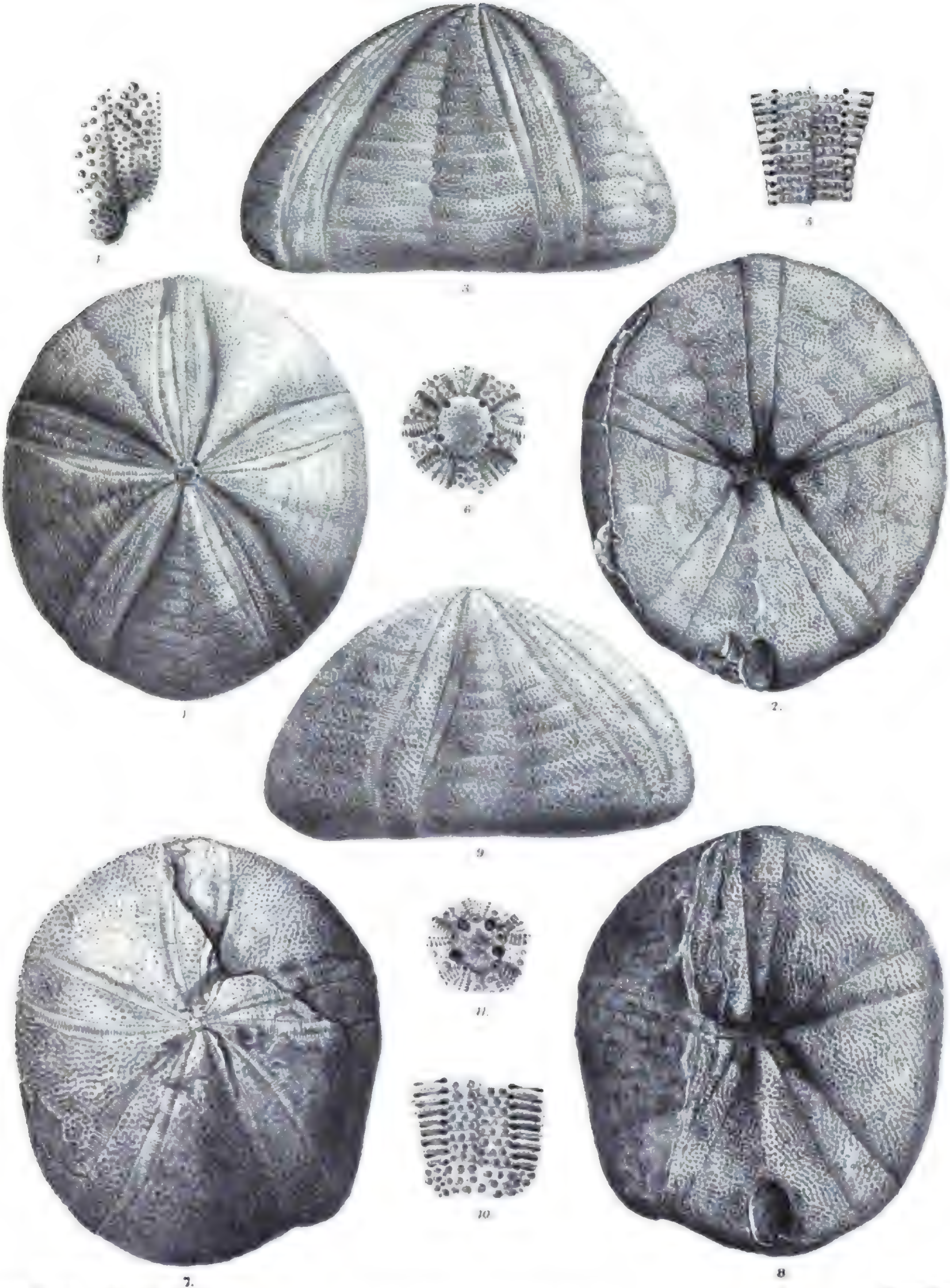
Fossil Echinoidea from Sind.
Khirthar Series

PLATE XXIII.

Figure 1. Conoclypeus alveolatus, Duncan and Sladen (page 124). Abactinal view of the test, natural size.

2. Actinal view of the test, natural size.
3. Longitudinal profile of the test, natural size.
4. A bourrelet and rudimentary phyllode, magnified.
5. Terminal extremity of an ambulacral petal, magnified.
6. Apical disk, magnified.
7. Conoclypeus pinguis, Duncan and Sladen (page 126). Abactinal view of the test, natural size.
8. Actinal view of the test, natural size.
9. Longitudinal profile of the test, natural size.
10. Terminal extremity of an ambulacral petal, magnified.
11. Apical disk, magnified.

Plate XXIII.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Duncan & Sladen dir. A.S. Foord lith.

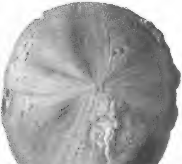
Mintern Bros. imp.

Fossil Echinoidea from Sind.
Khirthar Series.

PLATE XXIV.

Figure 1. Conoclypeus rostratus, Duncan and Sladen (page 128). Abactinal view of the test, natural size.

2. Longitudinal profile of the test, natural size.
3. A portion of the left posterior ambulacral petal, at its widest part, magnified.
4. Terminal extremity of the same petal, magnified.
5. Conoclypeus galerus, Duncan and Sladen (page 129). Abactinal view of a fragmentary test, natural size.
6. Longitudinal profile of the same specimen, natural size.
7. Longitudinal profile of another test, natural size.
8. A portion of an ambulacral petal, at its widest part, magnified. (Same test as figs. 5 & 6.)
9. Terminal extremity of the same petal, magnified.
10. Diagram showing the arrangement of the ambulacral plates on the actinal surface, near the peristome, magnified.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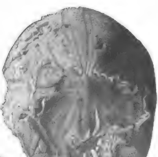
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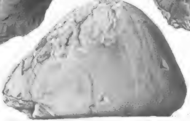
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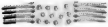
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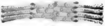
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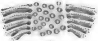
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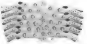
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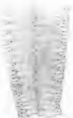
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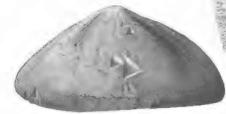
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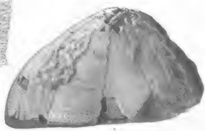
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Fossil Echinoidea from Sind.
Khirthar Series

PLATE XXV.

Figures 1–8. **Sismondia polymorpha**, Duncan and Sladen (page 137). Abactinal view of a series of specimens to show the variations of the marginal outline, natural size.
9. Abactinal view of the test of the same specimen as Fig. 8, magnified × 2½.
10. Actinal view of the same specimen, magnified × 2½.
11. Longitudinal profile of the same specimen, magnified × 2½.
12. Apical disk and surrounding portions of the test, magnified.
13. Peristome and surrounding portions of the test, magnified.
14. **Echinocyamus nummuliticus**, Duncan and Sladen (page 132). Abactinal view, natural size.
15. The same, magnified.
16. Actinal view of the test, magnified.
17. Longitudinal profile, magnified.
18. Transverse profile, magnified.
19. Apical disk and surrounding portions of the test, magnified.
20. Peristome and surrounding portions of test, magnified.
21. **Echinocyamus nummuliticus**, var. **obesus** (page 134). The test, natural size.
22. Abactinal view of the test, magnified.
23. Actinal view of the test, magnified.
24. Longitudinal profile, magnified.
25. **Echinocyamus nummuliticus**, var. **oviformis** (page 135). The test, natural size.
26. Abactinal view of the test, magnified.
27. Actinal view of the test, magnified.
28. Longitudinal profile, magnified.
29. **Echinocyamus nummuliticus**, var. **planus** (page 135). The test, natural size.
30. Abactinal view of the test, magnified.
31. Actinal view of the test, magnified.
32. Longitudinal profile, magnified.
33. **Echinocyamus rotundus**, Duncan and Sladen (page 135). The test, natural size.
34. Abactinal view of the test, magnified × 4.
35. Actinal view of the test, magnified × 4.
36. Longitudinal profile, magnified × 4.
37. Apical disk, magnified.

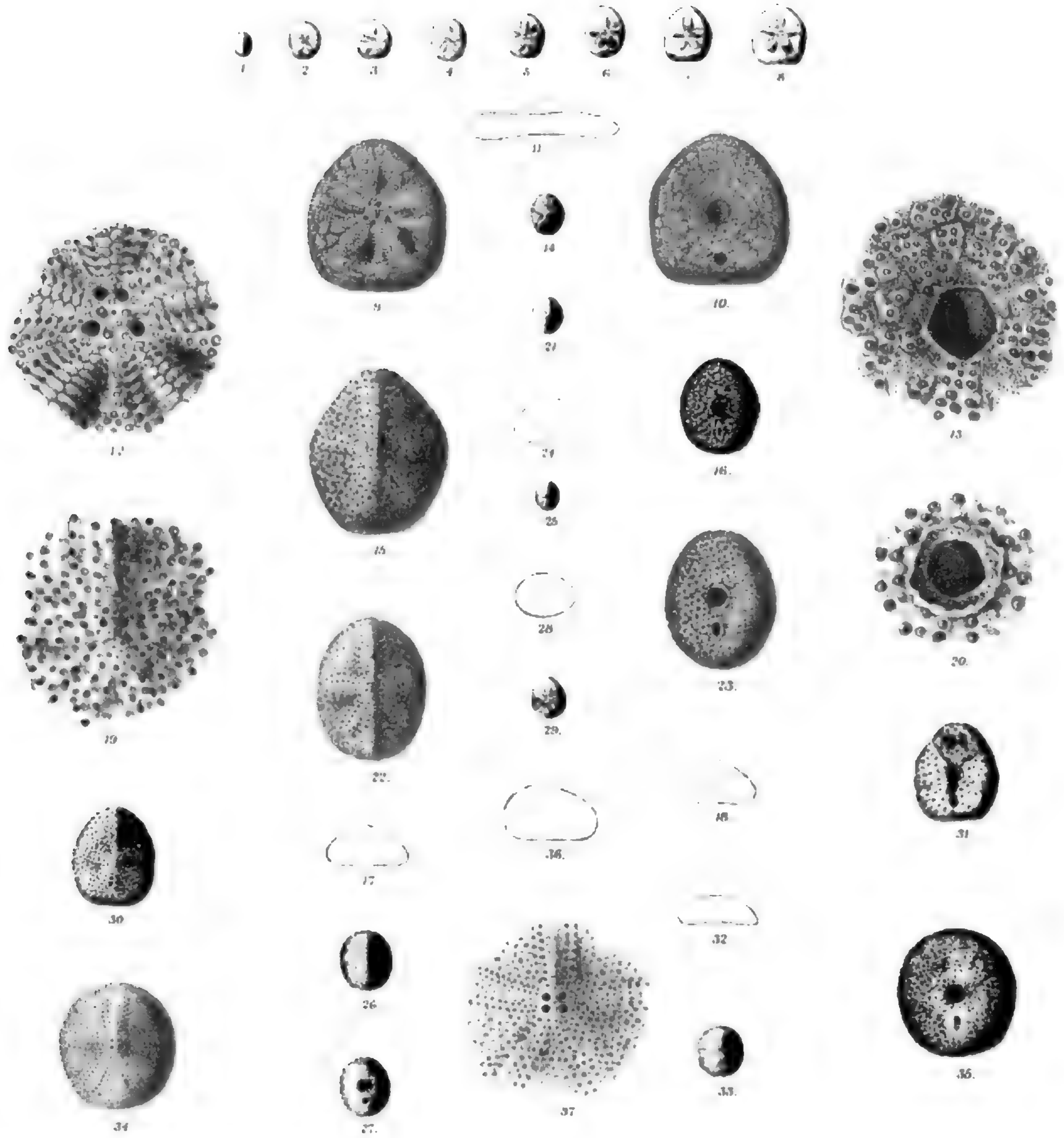
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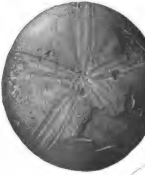
PLATE XXVI.

Figure 1. AMBLYPYGUS SUBROTUNDUS, Duncan and Sladen (page 140). Abactinal view of the test, natural size.

2. Actinal view of the test, natural size.
3. Longitudinal profile of the test, natural size.
4. Apical disk, from another specimen, slightly weather-worn, magnified.
5. Portion of the actinal surface of the same specimen, magnified.
6. Arrangement of the ambulacral plates near the middle of a petal, magnified.
7. Arrangement of the ambulacral plates near the ambitus, magnified.
8. Arrangement of the ambulacral plates on the actinal surface, midway between the peristome and the margin, magnified.
9. Abactinal view of the test of a young specimen measuring 40 millim. in length, natural size.
10. Longitudinal profile of the same specimen, natural size.
11. Abactinal view of the test of a young specimen measuring 58 millim., natural size.
12. Actinal view of the same specimen, natural size.
13. Longitudinal profile of the same, natural size.
14. Var. CONICUS. Longitudinal profile, natural size.



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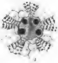

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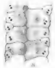

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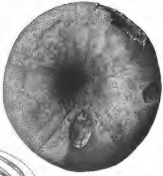

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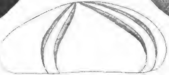

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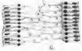

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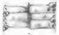

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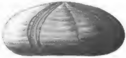

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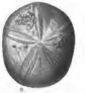

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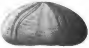

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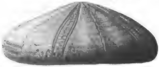

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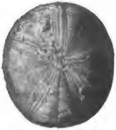

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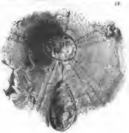

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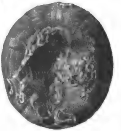

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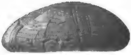
Fossil Echinoidea from Sind.
Khirthar Series

PLATE XXVII.

Figure 1. AMBLYPYGUS PATELLÆFORMIS, Duncan and Sladen (page 144). Abactinal view of the test, natural size.

2. Actinal view of the test, natural size.
3. Longitudinal profile of the test, natural size.
4. AMBLYPYGUS TUMIDUS, Duncan and Sladen (page 146). Abactinal view of the test, natural size.
5. Actinal view of the test, natural size.
6. Longitudinal profile of the test, natural size.
7. AMBLYPYGUS LATUS, Duncan and Sladen (page 148). Abactinal view of the test, natural size.
8. Actinal view of the test, natural size.
9. Longitudinal profile of the test, natural size.



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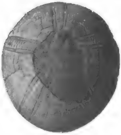

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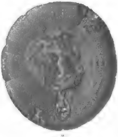

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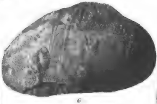

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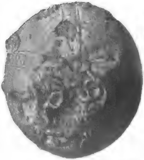

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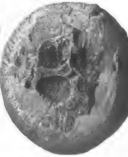

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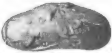

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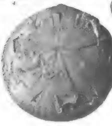

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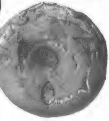

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Duncan & Sladen dir. [illegible] Mintern Bros. imp.

Fossil Echinoidea from Sind.
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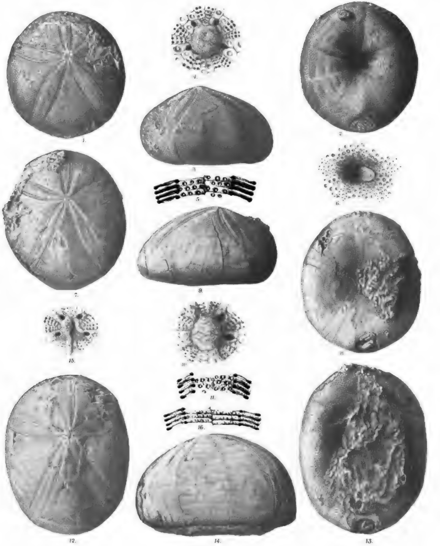
PLATE XXVIII.

Figure 1. Echinolampas rotunda, Duncan and Sladen (page 152). Abactinal view of the test, natural size.
2. Actinal view of the test, natural size.
3. Longitudinal profile of the test, natural size.
4. The apical disk, magnified.
5. A portion of a petal, about midway between the extremity and the apex, magnified.
6. The peristome and surrounding portions of the test, magnified.
7. Echinolampas subconica, Duncan and Sladen (page 155). Abactinal view of the test, natural size.
8. Actinal view of the test, natural size.
9. Longitudinal profile of the test, natural size.
10. The apical disk, magnified.
11. A portion of a petal about midway between the extremities, magnified.
12. Echinolampas obesa, Duncan and Sladen (page 157). Abactinal view of the test, natural size.
13. Actinal view of the test, natural size.
14. Longitudinal profile of the test, natural size.
15. The apical disk, magnified.
16. A portion of a petal, about midway between the extremities, magnified.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Duncan & Sladen del. A. S. Foord lith.

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Fossil Echinoidea from Sind.
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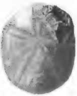
PLATE XXIX.

Figure 1. Echinolampas Sindensis, d'Archiac (page 159). Abactinal view of the test of a large example, natural size.

2. Longitudinal profile of the same specimen, natural size.
3. Abactinal view of a test of ordinary size, natural size.
4. Actinal view of the same, natural size.
5. Longitudinal profile of the same, natural size.
6. Peristome and surrounding parts of the test from another specimen, magnified.
7. A portion of the ambulacral area, near the middle of a petal, magnified.
8. Abactinal view of the test of a young specimen, natural size.
9. Actinal view of the same test, natural size.
10. Longitudinal profile of the same, natural size.
11. Echinolampas Sindensis, var. hemisphærica, Duncan and Sladen (page 163). Abactinal view of the test, natural size.
12. Actinal view of the same, natural size.
13. Longitudinal profile of the same, natural size.
14. Longitudinal profile of another specimen, somewhat less tumid, natural size
15. Longitudinal profile of a large specimen, natural size.
16. Abactinal view of the test of a small specimen, natural size.
17. Longitudinal profile of the same, natural size.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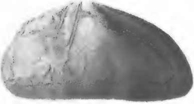
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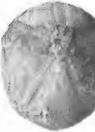
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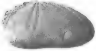
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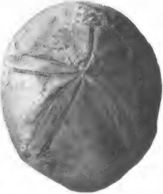
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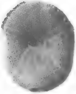
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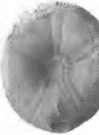
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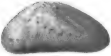
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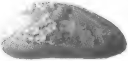
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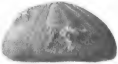
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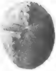
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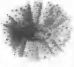
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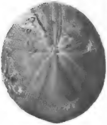
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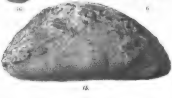
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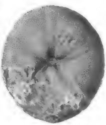
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Fossil Echinoidea from Sind.
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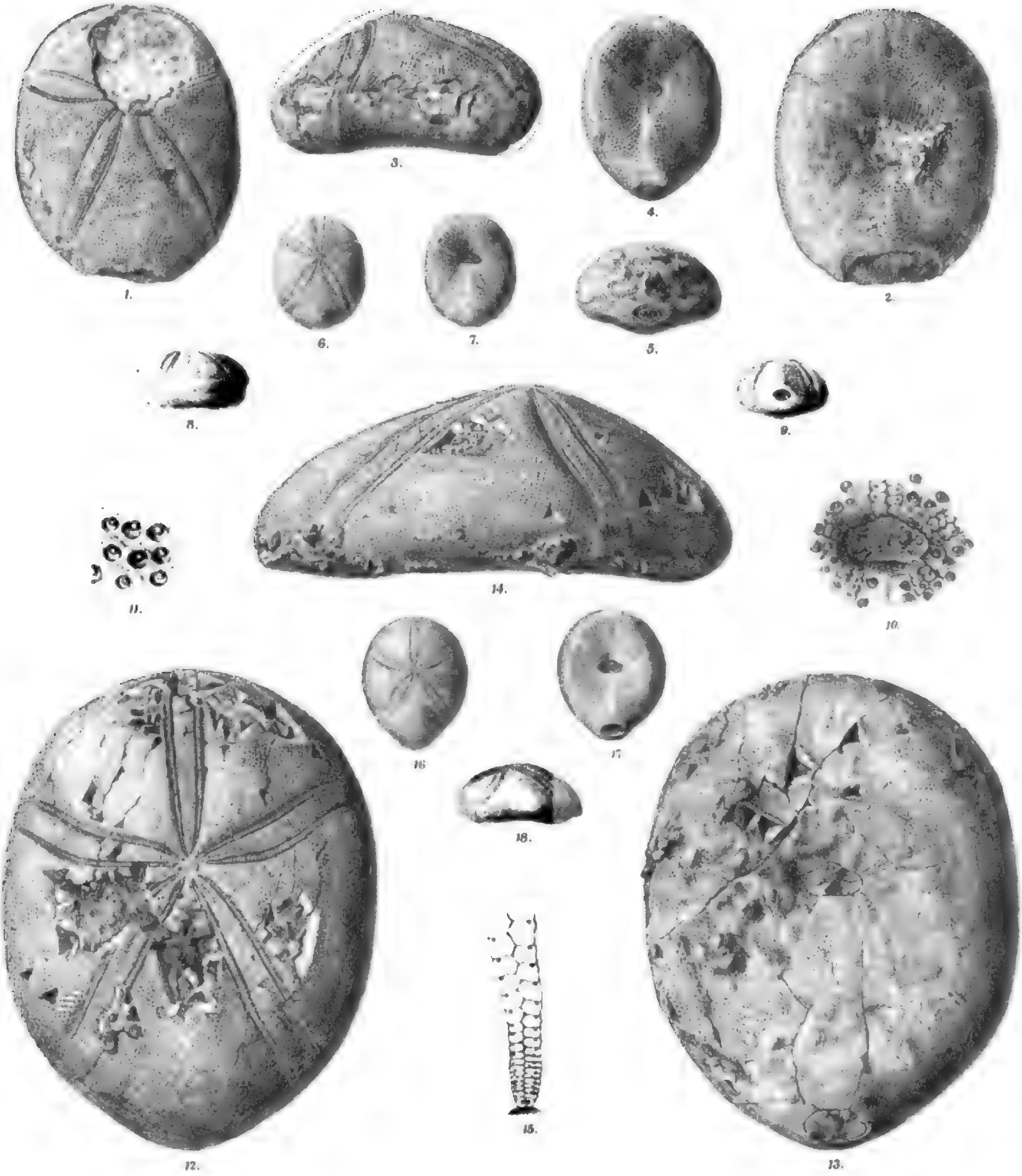
PLATE XXX.

Figure 1. Echinolampas angustifolia, Duncan and Sladen (page 164). Abactinal view of the test, natural size.

2. Actinal view of the same, natural size.
3. Longitudinal profile of the same, natural size.
4. Actinal view of a smaller specimen, natural size.
5. Transverse profile of the same specimen, seen from behind, natural size.
6. Abactinal view of the test of a young specimen, natural size.
7. Actinal view of the same, natural size.
8. Longitudinal profile of the same, natural size.
9. Transverse profile of the same, seen from behind, natural size.
10. Peristome of the same specimen, magnified.
11. Primary tubercles on the actinal surface of the same specimen, magnified.
12. Echinolampas nummulitica, Duncan and Sladen (page 167). Abactinal view of the test, natural size.
13. Actinal view of the test, natural size.
14. Longitudinal profile of the test, natural size.
15. Actinal portion of the left anterior ambulacrum, magnified.
16. Echinolampas juvenilis, Duncan and Sladen (page 170). Abactinal view of the test, natural size.
17. Actinal view of the test, natural size.
18. Longitudinal profile of the test, natural size.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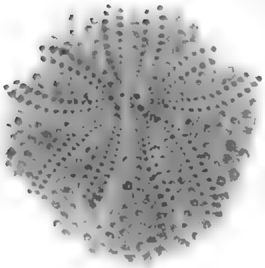
Duncan & Sladen del. A. S. Foord lith.

Mintern Bros. imp.

Fossil Echinoidea from Sind.
Khirthar Series

PLATE XXXI.

Figure 1. Echinolampas, sp. Junior (page 174). Abactinal view of the test, natural size.
2. Actinal view of the test, natural size.
3. Longitudinal profile of the test, natural size.
4. Abactinal area, showing the petals, magnified.
5. The peristome and surrounding portions of the test, magnified.
6. Echinolampas lepadiformis, Duncan and Sladen (page 172). Abactinal view of the test, natural size.
7. Actinal view of the test, natural size.
8. Longitudinal profile of the test, natural size.
9. Abactinal area, showing the petals, magnified.
10. The peristome and surrounding portions of the test, magnified.
11. Eolampas excentricus, Duncan and Sladen (page 150). Abactinal view of the test, natural size.
12. Actinal view of the test, natural size.
13. Longitudinal profile of the test, natural size.
14. Abactinal area, showing the petals, magnified.
15. The peristome and surrounding portions of the test, magnified.



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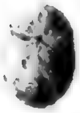

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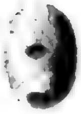

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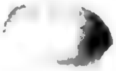

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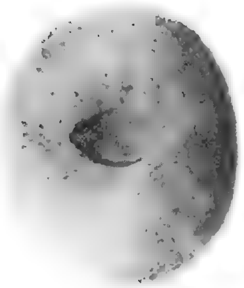

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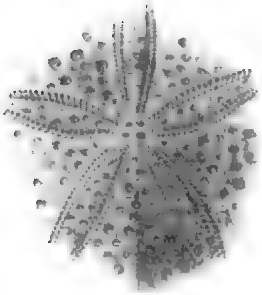

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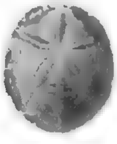

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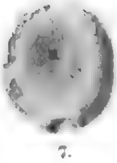

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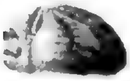

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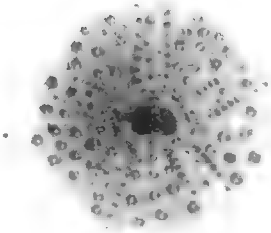

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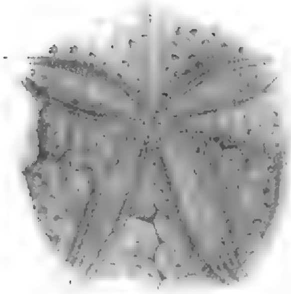

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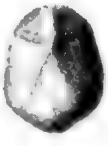

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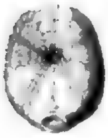

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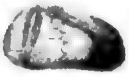

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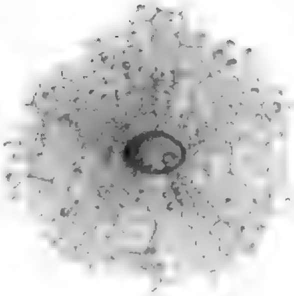

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Duncan & Sladen dir. A. S. Foord lith.

Mintern Bros. imp.

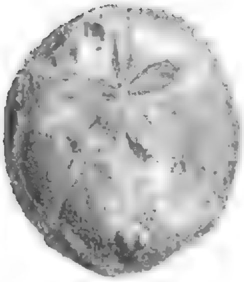
Fossil Echinoidea from Sind.

Khirthar Series.

PLATE XXXII.

Figure 1. ECHINOLAMPAS ÆQUIVOCA, Duncan and Sladen (page 173). Abactinal view of the test natural size.

2. Actinal view of the test, natural size.
3. Longitudinal profile of the test, natural size.
4. ECHINANTHUS INTERMEDIUS, Duncan and Sladen (page 177). Abactinal view of the test, natural size.
5. Actinal view of the test, natural size.
6. Longitudinal profile of the test, natural size.
7. Transverse profile, seen from behind, natural size.
8. The peristome and surrounding portions of the test, magnified.
9. ILARIONIA SINDENSIS, Duncan and Sladen (page 179). Abactinal view of the test, natural size.
10. Actinal view of the test, natural size.
11. Longitudinal profile of the test, natural size.
12. Transverse profile, seen from behind, natural size.
13. Abactinal area, showing the petals, magnified.
14. The peristome and surrounding portions of the test, magnified.
15. Abactinal view of the test of another specimen, natural size.
16. Longitudinal profile of the same test, natural size.
17. Abactinal view of the test of a small round example, natural size.
18. Longitudinal profile of the same test, natural size.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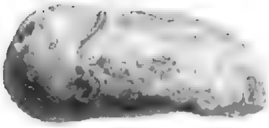
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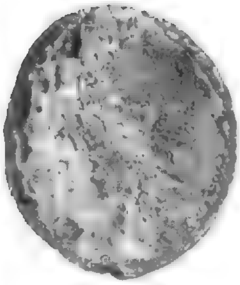
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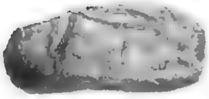
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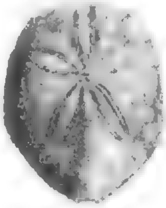
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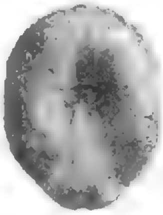
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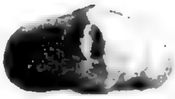
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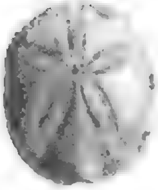
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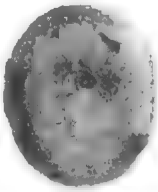
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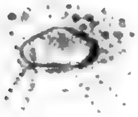
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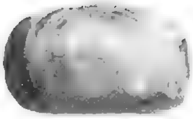
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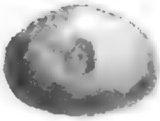
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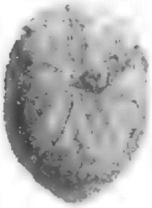
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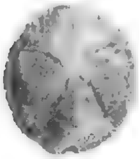
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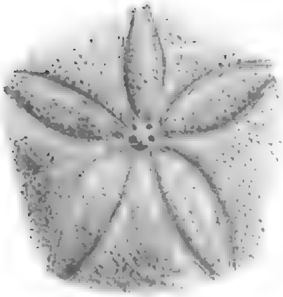
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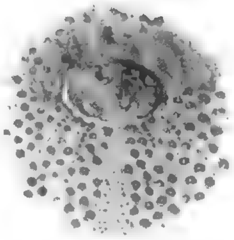
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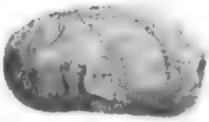
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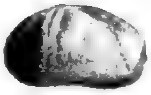
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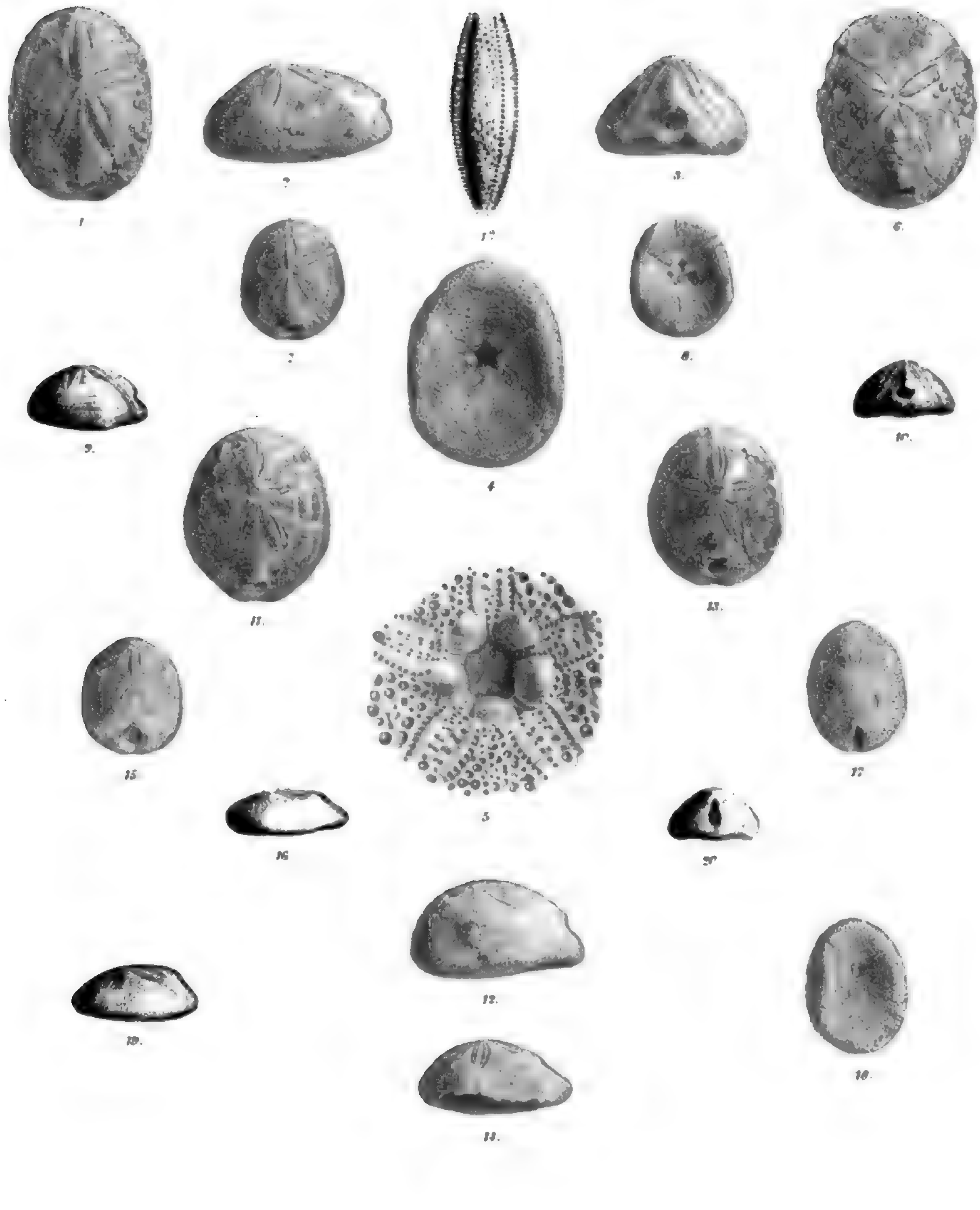
Duncan & Sladen, dir. A. S. Foord lith. Mintern Bros. imp.

Fossil Echinoidea from Sind.
Khirthar Series.

PLATE XXXIII.

Figure 1. Rhynchopygus Calderi, d'Archiac and Haime, sp. (page 184). Abactinal view of the test, natural size.

- 1 *a*. Ambulacral petal, magnified.
- 2. Longitudinal view of the same test, natural size.
- 3. The same test seen from behind, natural size.
- 4. Actinal view of another test, natural size.
- 5. The peristome and surrounding portions, magnified.
- 6. Abactinal view of an abnormal specimen, in which the odd anterior ambulacrum is aborted, natural size.
- 7. Rhynchopygus pygmæus, Duncan and Sladen (page 187). Abactinal view of the test, natural size.
- 8. Actinal view of the test, natural size.
- 9. Longitudinal profile of the same test, natural size.
- 10. The same test seen from behind, natural size.
- 11. Abactinal view of the test of a large, widely expanded, high form, natural size.
- 12. Longitudinal profile of the same test as fig. 11, natural size.
- 13. Abactinal view of the test of another large form, natural size.
- 14. Longitudinal profile of the same test as fig. 13, natural size.
- 15. Abactinal view of the test of a flat, depressed variety, natural size.
- 16. Longitudinal profile of the same test as fig. 15, natural size.
- 17. Cassidulus subinvaginatus, Duncan and Sladen (page 182). Abactinal view of the test, natural size.
- 18. Actinal view of the test, natural size.
- 19. Longitudinal profile of the test, natural size.
- 20. The test seen from behind, natural size.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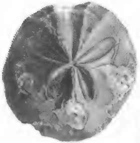
Duncan & Sladen del. A.S. Foord lith. Mintern Bros. imp.

Fossil Echinoidea from Sind.
Khirthar Series

PLATE XXXIV.

Figure 1. Hemiaster apicalis, Duncan and Sladen (page 193). Abactinal view of the test, natural size.
2. Longitudinal profile of the test, natural size.
3. Front view of the test, natural size.
4. Apical disk, magnified.
5. Portion of the odd anterior ambulacrum, magnified.
6. Portion of one of the antero-lateral petals, magnified.
7. Ornamentation of the test near (above) the ambitus in one of the anterior interradia, magnified.
8. Hemiaster nobilis, Duncan and Sladen (page 196). Abactinal view of the test, natural size.
9. Longitudinal profile of the test, natural size.
10. Portion of the odd anterior ambulacrum, magnified.
11. Portion of one of the antero-lateral petals, magnified.
12. Hemiaster carinatus, Duncan and Sladen (page 198). Abactinal view of the test, natural size.
13. Portion of the odd anterior ambulacrum, magnified.
14. Portion of one of the antero-lateral petals, magnified.
15. Schizaster simulans, Duncan and Sladen (page 223). Abactinal view of the test, natural size.
16. Longitudinal profile of the test, natural size.
17. Gen. et sp. indet. (page 241). Abactinal view of the test, natural size.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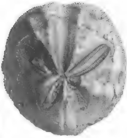
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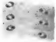
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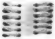
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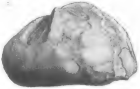
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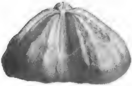
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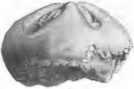
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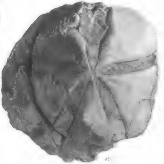
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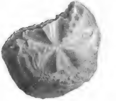
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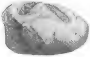
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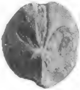
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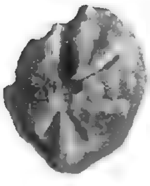
Duncan & Sladen del. A. S. Foord lith. Mintern Bro's imp.

Fossil Echinoidea from Sind.
(Khirthar Series)

PLATE XXXV.

Figure 1. Moira primæva, Duncan and Sladen (page 225)*. Abactinal view of the test, natural size.
2. Longitudinal profile of the test, natural size.
3. Ornamentation of plates in the lateral interradium, magnified.
4. Hemiaster digonus, d'Archiac (page 200). Abactinal view of the test, natural size.
5. Actinal view of the test, natural size.
6. Longitudinal profile of the test, natural size.
7. A portion of the abactinal surface, to show the apical disk, the ambulacral petals, and the fasciole, magnified.
8. Abactinal view of a test with very broad anterior groove, natural size.
9. Abactinal view of a test, with apical disk very excentric posteriorly, natural size.
10. Metalia Sowerbyi, d'Archiac, sp. (page 206). Abactinal view of the test, natural size.
11. Actinal view of the test, natural size.
12. Longitudinal profile of the test, natural size.
13. A portion of the abactinal surface to show the apical disk and ambulacra, magnified.
14. Abactinal view of the test of a young specimen, natural size.
15. Actinal view of the same, natural size.
16. Longitudinal view of the same, natural size.
17. Brissopsis sufflatus, Duncan and Sladen (page 203). Abactinal view of the test, natural size.
18. Actinal view of the test, natural size.
19. Longitudinal profile of the test, natural size.
20. A portion of the abactinal surface to show the apical disk and the ambulacral petals, magnified.
21. Abactinal view of the test of a young example, natural size.
22. Actinal view of the same test, natural size.
23. Longitudinal profile of the same, natural size.
24. A portion of the abactinal surface, magnified.
25. Hemiaster, sp. (page 201). Abactinal view of the test, natural size.
26. Actinal view of the test, natural size.

* This species is probably included by accident in the Khirthar series.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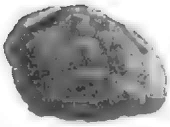
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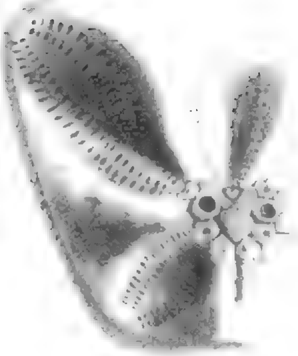
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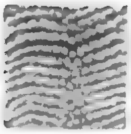
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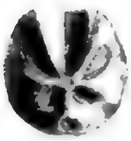
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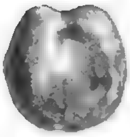
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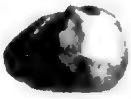
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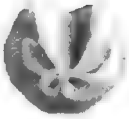
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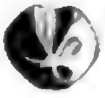
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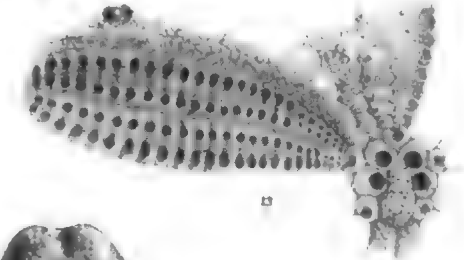
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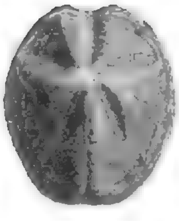
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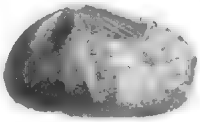
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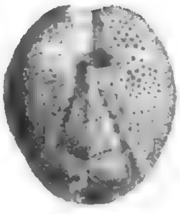
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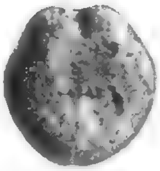
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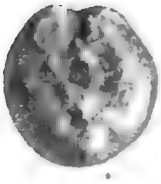
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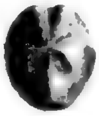
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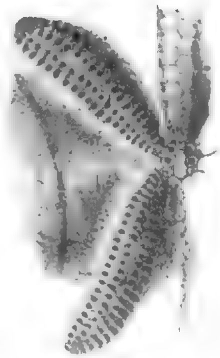
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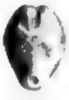
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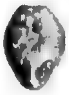
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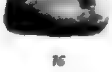
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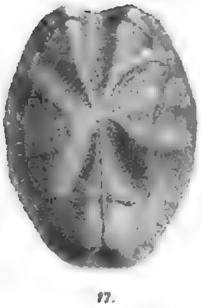
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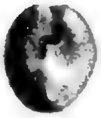
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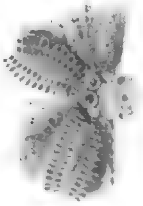
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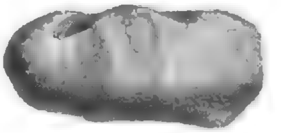
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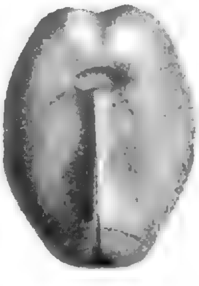
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Duncan & Sladen del. A. S. Foord lith. Mintern Bros imp.

Fossil Echinoidea from Sind.
Khirthar Series

PLATE XXXVI.

Figure 1. **Metalia scutiformis**, d'Archiac, sp. (page 209). Abactinal view of the test, natural size.

2. Actinal view of the test, natural size.

3. Longitudinal profile of the test, natural size.

4. The apical disk, magnified.

5. A portion of the abactinal surface, to show the antero-lateral petal and the fasciole, magnified.

6. **Metalia scutiformis** (?) **var. rotunda**, Duncan and Sladen (page 211). Abactinal view of the test, natural size.

7. Longitudinal profile of the test, natural size.

8. **Metalia depressa**, Duncan and Sladen (page 211). Abactinal view of the test, natural size.

9. Longitudinal profile of the test, natural size.

10. A portion of the abactinal surface, to show the apical disk, the ambulacral petals, and the fasciole, magnified.

11. **Metalia agariciformis**, Duncan and Sladen (page 213). Abactinal view of the test, natural size.

12. Actinal view of the test, natural size.

13. Longitudinal profile of the test, natural size.

14. A portion of the abactinal surface, to show the apical disk and the ambulacral petals, magnified.

15. **Metalia**, sp. (page 215). Abactinal view of the test, natural size.

16. Longitudinal profile of the test, natural size.

17. **Metalia**, sp. (page 216). Abactinal view of the specimen, natural size.

18. **Peripneustes**, sp. (page 234). Abactinal view of the test, natural size.

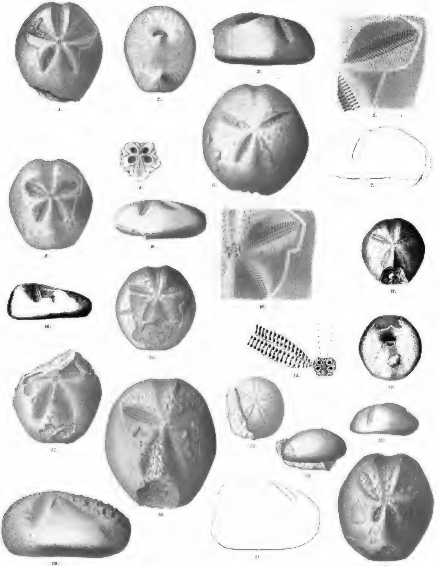
19. Longitudinal profile of the test, natural size.

20. **Schizaster**, sp. (page 224). Abactinal view of the test, natural size.

21. Longitudinal profile of the test, natural size.

22. **Echinolampas**, sp. (page 176). Abactinal view of the test, natural size.

23. Longitudinal profile of the test, natural size.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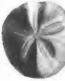
Duncan & Sladen del. A. Gawan lith.

Mintern Bros. imp.

Fossil Echinoidea from Sind.
Khirthar Series.

PLATE XXXVII.

Figure 1. **Micraster tumidus**, Duncan and Sladen (page 189). Abactinal view of the test, natural size.
2. Actinal view of the test, natural size.
3. Longitudinal profile of the test, natural size.
4. Odd anterior ambulacrum, magnified.
5. Portion of one of the petaloid ambulacra, magnified.
6. Apical disk, magnified.
7. **Linthia orientalis**, Duncan and Sladen (page 217). Abactinal view of the test, natural size.
8. Actinal view of the test, natural size.
9. Longitudinal profile of the test, natural size.
10. Odd anterior ambulacrum, magnified.
11. Portion of one of the petaloid ambulacra, magnified.
12. Apical disk, magnified.
13. Abactinal view of an abnormal unsymmetrical test, natural size.
14. Abactinal view of another abnormal unsymmetrical test, natural size.
15. **Schizaster symmetricus**, Duncan and Sladen (page 220). Abactinal view of the test, natural size.
16. Actinal view of the test, natural size.
17. Longitudinal profile of the test, natural size.
18. The test seen from behind, natural size.
19. Odd anterior ambulacrum, magnified.
20. Portion of one of the petaloid ambulacra, magnified.
21. Apical disk, magnified.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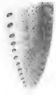
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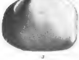
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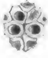
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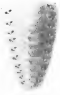
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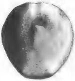
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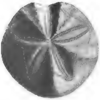
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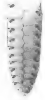
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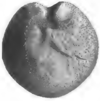
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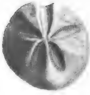
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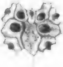
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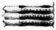
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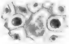
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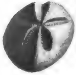
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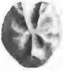
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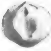
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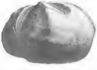
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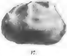
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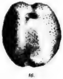
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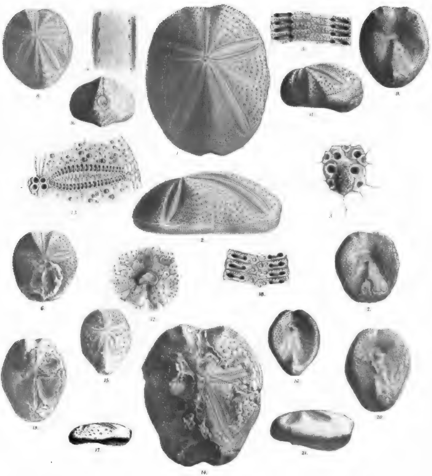
Mintern Bros imp.

Fossil Echinoidea from Sind.
Khirthar Series

PLATE XXXVIII.

Figure 1. MACROPNEUSTES SPECIOSUS, Duncan and Sladen (page 229). Abactinal view of the test, natural size.
2. Longitudinal profile of the test, natural size.
3. Apical disk, magnified.
4. Portion of the odd anterior ambulacrum, magnified.
5. Portion of the antero-lateral ambulacrum, magnified.
MACROPNEUSTES ROTUNDUS, Duncan and Sladen (page 232). Abactinal view of the test, natural size.
7. Actinal view of the test, natural size.
8. EUSPATANGUS AVELLANA, d'Archiac and Haime (page 235). Abactinal view of the test, natural size.
9. Actinal view of the test, natural size.
10. Transverse profile of the test, seen from behind, natural size.
11. Longitudinal profile of the test, natural size.
12. The peristome and surrounding portions of the test, magnified.
13. The apical disk, the odd anterior ambulacrum, and the right antero-lateral petal, magnified.
14. EUSPATANGUS CORDIFORMIS, Duncan and Sladen (page 238). Abactinal view of the test, natural size.
15. EUSPATANGUS ROSTRATUS, d'Archiac (page 240). Abactinal view of the test, natural size.
16. Actinal view of the test, natural size.
17. Longitudinal profile of the test, natural size.
18. Portion of a lateral ambulacrum, to show ornamentation, magnified.
19. BRISSOPATAGUS SINDENSIS, Duncan and Sladen (page 226). Abactinal view of the test, natural size.
20. Actinal view of the test, natural size.
21. Longitudinal profile of the test, natural size.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Duncan & Sladen dir. A.S. Foord lith.

Mintern Bros. imp.

Fossil Echinoidea from Sind.
Khirthar Series.

MEMOIRS

OF THE

GEOLOGICAL SURVEY OF INDIA.

Palæontologia Indica,

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING
THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL.

TERTIARY AND UPPER CRETACEOUS FOSSILS OF WESTERN SIND.

Ser. XIV.

Vol. I. 3. THE FOSSIL ECHINOIDEA.

Fasciculus IV. THE FOSSIL ECHINOIDEA FROM THE NARI SERIES, THE OLIGOCENE FORMATION OF WESTERN SIND.

WITH 5 PLATES.

BY

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A DESCRIPTION

OF THE

FOSSIL ECHINOIDEA

OF

WESTERN SIND.

Fasciculus 4.—THE NARI SERIES (OLIGOCENE).

Plates XXXIX.-XLIII.

1. *Introductory Remarks on the Nari Series.*

The geographical and geological position of the Nari series has been described on a former page* of this description of the Tertiary Fossil Echinoidea of Sind, and the details of the succession of its strata also. It appears that this thick series is to be divided into an upper and lower group, the first attaining the great thickness of 4000 to 6000 feet, and the latter from 100 feet to 1500 feet. The lower group, which is fossiliferous and contains the Corals already described †, rests conformably on the underlying Khirthar series. Its very fossiliferous strata are not more than 100 feet thick; and there is a clear biological break, for *Nummulites* begin to be scarce in species and *Orbitoides* come in.

The Upper Nari series is unconformable to the lower, and whilst in some areas there are marine fossils indicated by the presence of *Orbitoides papyracea*, in others there are sandstones which have only yielded plants.

The commonest Nummulite is *Nummulites Garansensis*; and the most important Corals common to the Nari and the European equivalent strata are:—*Trochocyathus cyclolitoides*, Ed. & H., of Rosazzo in Friuli, and S. Giovanni Ilarione; *Stylophora*

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* Fasciculus 1, p. 4.

† Duncan, Pal. Ind. Ser. XIV., Fossil Corals of Sind. See also Medlicott and Blanford, 'Geology of India,' vol. ii. p. 459.

pulcherrima, d'Achiardi, from Friuli; *Trochosmilia varicosa*, Reuss, from Crosara; and *Stylocœnia taurinensis*, Ed. & H., and *Cycloseris Perizi*, Ed. & H., from the same, or a slightly higher horizon in the instance of the *Stylocœniæ*. On the whole, the Coral-fauna was littoral and stunted.

It was the belief of the distinguished authors of the 'Geology of India' that the Nari group was, palæontologically as well as stratigraphically, in a position intermediate between the Khirthar and the Gáj groups. The results of our work in the palæontology of the Corals and the Echinoidea quite confirm this view; but it is necessary to modify some of the statements made in the 'Geology of India' regarding the vertical range of some of the species mentioned therein. The following is the *résumé* given by Messrs. Medlicott and Blanford, *op. cit.* p. 462:—"Although some species pass from the Khirthar, and even from the Ranikot group, into the Nari beds, the fauna is chiefly distinct and marks a higher horizon. The most marked change is perhaps in the Foraminifera, because they are so abundant and characteristic: whole beds of limestone towards the base of the Nari group being entirely made up of *Nummulites Garansensis*, *N. sublævigata*, and *Orbitoides papyracea*, the last-named frequently of large size, some specimens being two to three inches in diameter; yet every species is distinct from those occurring in the Khirthar group. One of the species of Nummulites, *N. Garansensis*, is of importance, because it appears in Europe, as in Sind, in the highest strata characterized by the abundance of the genus, those beds being at the base of the Miocene. *N. sublævigata* is peculiar, so far as is known, to India. Several of the Mollusca and Echinodermata of the Nari beds also—such as *Siliquaria Granti*, *Solarium affine*, *Venus granosa*, and *Clypeaster profundus*—show distinctly Miocene affinities, and some of these pass up into the Gáj group. But at the same time there are so many Eocene forms present, such as *Natica patula*, *N. sigaretina*, *Ostrea flabellula*, *Voluta jugosa*, &c., that it is somewhat difficult to decide to which subdivision the Nari beds should be assigned. They may perhaps occupy an intermediate position, similar to that of the Oligocene of continental geologists."

We find that the Echinoidea of the Nari group are very characteristic, and that only one reliable species of the collection sent to us passes up into the Gáj group, viz. *Schizaster Granti*, nobis, which is the common *Schizaster* of the Miocene of Kachh and Kattywar, and which can be readily mistaken for *S. Baluchistanensis*, d'Arch. & Haime. This last-mentioned *Schizaster* is not found in the Nari beds. *Euspatangus rostratus*, d'Arch., is common in the Khirthar group and in the Nari beds, but the *Clypeasters* of the Nari group are peculiar.

There is a mutilated specimen of a variety of *Cœlopleurus Forbesi*, d'Arch. & Haime, in the Nari collection; and if it is really a Nari form, which is a matter of doubt, this species must be included in the Nari fauna. But in Kachh it is only found in the Miocene.

The existence of an Oligocene series in Sind is as well established as it is in Kachh.

Of the Echinoidea mentioned in the Survey of Sind as characteristic of the Nari group, only one really is so. The forms which were collected should come under other names; for those given to them arose from conscientious attempts to identify specimens with the descriptions of MM. d'Archiac and Haime.

II. *List of the Fossil Echinoidea from the Nari Series.*

Order ECHINOIDEA ENDOCYCLICA.

Family CIDARIDÆ.

Genus Cidaris, *Klein*, 1734.

Cidaris sp.: p. 250.

Family ARBACIADÆ.

Genus Cœlopleurus, *Agassiz*, 1840.

Cœlopleurus equis, *Agassiz*: p. 251.
(syn. —— coronalis, *Klein*.)
—— Pratti, *d'Archiac & Haime*: p. 254.
—— Forbesi, *d'Archiac & Haime*?: p. 256.

Order ECHINOIDEA EXOCYCLICA.

Suborder GNATHOSTOMATA.

Family CLYPEASTRIDÆ.

Subfamily Euclypeastrinæ.

Genus Clypeaster, *Lamarck*, 1801.

Clypeaster simplex, *Duncan & Sladen*: p. 257.
—— monticulifera, *Duncan & Sladen*: p. 258.
—— sp.: p. 257.

Suborder ATELOSTOMATA.

Family CASSIDULIDÆ.

Subfamily Echinolampinæ.

Genus Echinolampas, *Gray*, 1825.

Echinolampas difficilis, *Duncan & Sladen*: p. 258.
—— d'Archiaci, *Duncan & Sladen*: p. 259.
—— Radakensis, *Duncan & Sladen*: p. 260.
—— discoideus, *d'Archiac*: p. 261.
—— ——, var. α, *Duncan & Sladen*: p. 262.
—— ——, var. β, *Duncan & Sladen*: p. 263.
—— ——, var. γ, *Duncan & Sladen*: p. 263.
—— placenta, *Duncan & Sladen*: p. 264.
—— tumida, *Duncan & Sladen*: p. 265.
—— ——, var., *Duncan & Sladen*: p. 267.

Family SPATANGIDÆ.

Genus Euspatangus, *Agassiz*, 1847.

Euspatangus rostratus, *d'Archiac*: p. 267.

Genus Schizaster, *Agassiz*, 1836.

Schizaster Granti, *Duncan & Sladen*: p. 268.

List of the Species of Fossil Echinoidea from the Nari Series (Oligocene).

1. Cidaris, sp.: p. 250.
2. Cœlopleurus equis, *Agassiz*: p. 251.
3. —— Pratti, *d'Archiac & Haime*: p. 254.
4. —— Forbesi, *d'Archiac & Haime*: p. 256.
5. Clypeaster simplex, *Duncan & Sladen*: p. 257.
6. —— monticulifera, *Duncan & Sladen*: p. 258.
7. —— sp.: p. 257.
8. Echinolampas difficilis, *Duncan & Sladen*: p. 258.
9. —— d'Archiaci, *Duncan & Sladen*: p. 259.
10. —— Radakensis, *Duncan & Sladen*: p. 260.
11. —— discoideus, *d'Archiac*: p. 261.
12. —— ——, var. α, *Duncan & Sladen*: p. 262.
13. —— ——, var. β, *Duncan & Sladen*: p. 263.
14. —— ——, var. γ, *Duncan & Sladen*: p. 263.
15. —— placenta, *Duncan & Sladen*: p. 264.
16. —— tumida, *Duncan & Sladen*: p. 265.
17. —— ——, var., *Duncan & Sladen*: p. 267.
18. Euspatangus rostratus, *d'Archiac*: p. 267.
19. Schizaster Granti, *Duncan & Sladen*: p. 268.

Total species and varieties, 19.

III. *Descriptions of the Species.*

Order ECHINOIDEA ENDOCYCLICA.

Family CIDARIDÆ.

Genus CIDARIS, *Klein*, 1734.

1. Cidaris, sp. Plate XXXIX, Figs. 1 & 2.

There are three very indifferent specimens of a *Cidaris* in the collection from the Nari beds; they are, however, better preserved than the specimens from which MM. d'Archiac and Haime determined their *Cidaris Verneuili*. This last-mentioned species has given us great trouble, for the description of it is not satisfactory. It was founded upon very imperfect specimens, and the special characters of the form turn out not to be very well defined. The specimens of a *Cidaris* in the collection now under consideration present some of the characters of *C. Verneuili*, but careful examination proves that the species are distinct.

The shape of the Nari specimens is rather low, flat above and below, and rounded at the sides. The median area of the interambulacra is large, broad, and marked with long furrows which reach from the scrobicular margin of the great tubercles to the median sutural line. There is a raised and narrow surface between each pair of grooves which is marked with distant and very visible miliaries, in one row. There is often great irregularity in the direction of the furrows, and they then stretch across the median line and appear to merge into those of the opposite plate. The small tubercles around the scrobicular margin are distant, and have their mamelon elongate in shape and low. On the ambulacral side of the scrobicular margin there is considerable space, and it is occupied by furrows and ridges similar to those of the opposite side, but they are shorter; they are longer, however, than in *C. Verneuili.* The coronal plates are much broader than high, and they are separated from those above and below by a decided sutural furrow and by the small tubercles of the scrobicular margin. Moreover the scrobicular spaces of the great tubercles are just separated by the furrow and the thin line of small tubercles. There are ten or thirteen pairs of pores in relation to each coronal plate, and the ridges and furrows come close to them from the scrobicules. Some of the pairs are conjugate, others are not. It appears that there is a minute miliary granulation upon the interporiferous zones, and that it is carried on to the structure between the pores.

The dimensions of the specimens is about—breadth 62 millim., height 32 millim.?

Locality. Nari series, Oligocene of Sind. Hindi Hill; Trak Hill. Survey-numbers G $\frac{302}{67}$, G $\frac{226}{81}$.

Illustrations of the Species in Plate XXXIX.

Fig. 1. Side view of the test.
2. A coronal plate and part of an ambulacrum: magnified.

Family ARBACIADÆ.

Genus CŒLOPLEURUS, *Agassiz*, 1840.

Small Urchins more or less depressed, sometimes a little elongate; with a thin test and simple pores. Tubercles neither crenulate nor perforate. Peristome small and slightly incised. Larger interambulacral tubercles disappear before reaching the abactinal surface, only secondary tubercles reaching the apex in some species, so that the interradia, above, resemble smooth bands which are often highly ornamented. The ambulacra project and have two rows of tubercles.

1. **CŒLOPLEURUS EQUIS**, *Agassiz.* Plate XXXIX, Figs. 3–8.

D'Archiac and Haime (*op. cit.* p. 198) describe *Cœlopleurus coronalis*, Klein, from the French Nummulitic, as a species found in the "Chaine d'Hala." This species has the synonyms of *C. equis*, Agass. (*Catal. Syst.* p. 12), and *C. nitidus*, König, sp., and is characterized by the presence of a single row of secondary tubercles smaller than the primaries extending along the flanks of the poriferous zone of the ambulacra from the apex to the peristome; they are small abactinally, and increase in size at the ambitus. The ambulacra project considerably.

Unfortunately d'Archiac and Haime described this species from a very imperfect specimen, and necessarily limited the number of smaller tubercles in relation to the large primaries of the interradia. They state there are seven large tubercles in each vertical series flanked externally by a row of five smaller, some unequal granulations intervening between them.

Desor gives a figure of this species (Synopsis des Échinides Fossiles, plate xvi, figs. 4–6). The specific distinctions are clearly given:—1. The pentagonal and depressed shape of the test. 2. The protuberance of the ambulacra. 3. Well-developed tubercles; primaries in the interporiferous area up to the beginning of the ambulacrum. 4. Actinally, a distinct row of secondary tubercles, large in size, between the rows of the primaries of the interradia and the poriferous zone of the ambulacra. This row extends in a single vertical series of secondary tubercles to the ambitus, and there is a smaller, but equally linear series, reaching to the abactinal system. 5. Primary tubercles in the interradium above the ambitus, two or they may be three in number, small, and not extending on the wide bare median space.

There are two types of this species in the Nari series. One is as depressed as Desor's type, and the other is a little higher. The vertical row of secondaries, much smaller than the interradial primaries, and of about the size of the small ambulacral primaries near the radial (ocular) plates, is very distinct and characteristic.

The apical system is large and the anal rim projects upwards slightly; there are five or six large miliaries in a row on the madreporite at the rim-edge, and about three to five on each of the other basal (generative) plates, either in a curve or straight line. A knob larger than these miliaries is on each basal plate. The basals (generative plates) are large and unequal; the madreporite is much the largest, and that of the interradium No. 1 (Lovén) is a little smaller, and the others are decidedly smaller. They have a blunt angular process adorally; and in one specimen the generative pores, large and open, are near the outer margin of most of the plates, but they are central in another. The radial (optic) plates are sunken, not very large, and have the outer or actinal margin with a reentering curve. On the plates are miliaries and ridges, in an arch which completes, as it were, the ambulacral petal, and also a row of granules. There is a central projection on the adoral edge which separates the optic foramen into two, which are hidden. The anal opening is large and oblique, its long axis passing through interradium 3 and ambulacrum I. (Lovén).

There are twenty-two primary tubercles in each ambulacrum, and they increase in size from the peristome to the ambitus, and diminish to the abactinal end. The smallest tubercle is close to the radial (optic) plate. The ambulacra are very prominent above the ambitus, but are not more projecting than the interradia, when the test is seen from the actinal surface. The narrowness of the ambulacra is evident, and the tubercles are close; there is an incomplete row of large miliaries along the median suture, and large shallow pits are at the sutural angles in the median line near the peristome. The peristomial cuts are small; and the width of the peristomial end of the ambulacra is equal to that of the interradia in that position.

The pairs of pores of the ambulacra are in slightly curved triplets, from close to the apical system downwards, and at the ambitus the inner pore of each pair is within the line of the circumference of the base of the tubercle close by. The lower pair of the triplet is at the lower edge of the tubercle, and a little more towards the median line than the others.

In well-preserved specimens there is on every plate which carries a large primary, a smaller tubercle, and it is placed (Plate XXXIX, Fig. 6) near the adoral and outer edge. Above the ambitus, where the larger tubercles cease, the secondary persists on each plate and occupies the same relative position as elsewhere (Fig. 5).

The interradial tubercles diminish in size above and below the ambitus, and there are two visible from above. The greater part of the median surface above the tubercle-bearing plates is plain. There are zigzag lines, and there is an ornamentation on each plate, which, starting from the vertical miliary and tuberculate edge on the outer third, forms angular ridges and grooves which impinge on the median sutural lines, and unite these with those of the opposed plates (Fig. 5). The ornamentation of the outer third of the plate consists of a narrow raised vertical ridge of elongate granules; beyond this is a vertical row of distant small secondaries, one tubercle being placed on the lower and outer angle of each plate. Between these secondaries are a few large miliaries, sometimes in rows of threes or fours. It is this row of small tubercles which characterizes the species. Usually there is but one small tubercle on each plate, but towards the ambitus there may be two, but this is not universal. There is more miliary tuberculation between the tubercles at the ambitus and lower down for a short space than elsewhere. All the primary and secondary tubercles have a broad base, no sunken scrobicule, and a small projecting mamelon. The lowest of the vertical row of secondaries is small, and it is turned slightly out of its line by the existence of a long angular tag or continuation of the peristomial cut. Each tag extends up the ambulacrum as high as the third set of triplets, and is marked by some of the sutures of the poriferous plates. Between the primaries of the interradia there is a small row of miliaries; it extends along the median and partly transverse sutural lines.

Dimensions. Height 16 millim., length 27 millim.

Locality. Nari series, Oligocene of Sind. West side of Bhagothoro Hill, south of Sehwan. Survey-number G $\frac{229}{76}$.

Illustrations of the Species in Plate XXXIX.

Fig. 3. The test, abactinal view.
4. The side view.
5. Interradial plates, lower part of 4th and the whole of the 5th from the apex: magnified.
6. Interradial plate at ambitus: magnified.
7. The triplets of pores and an ambulacral tubercle, actinal surface.
8. The apical disk: magnified.

2. Cœlopleurus Pratti, *d'Archiac & Haime.* Plate XXXIX, Figs. 9–12.

The following is the diagnosis of MM. d'Archiac and Haime (*op. cit.* p. 199):—The test is subcircular and moderately high and rather convex above; periproct rather small, and the generative pores large and opening in the middle of the genital plates, which are rather longer than broad, and slightly angular externally. Ambulacral areas three fourths the breadth of the interradia. Pores in rather close pairs, which form in the actinal half short series of slightly inclined triplets. The pores are large, circular, those of the same pair nearly horizontal, separated by a broader space abactinally than actinally. Twelve ambulacral plates for each vertical series, almost as high as broad, and pierced by three pairs of pores; their internal two thirds are occupied by a large projecting primary, and there are fine granulations on the sutural lines. The interradia consist of twelve plates, which are usually twice as high as broad. They have a vertical line which is granular and projecting, which limits the abactinal smooth median area, and which actinally divides the plates in half; the internal part there is covered with a large tubercle, and the outer with a moderately large tubercle and a smaller one external to it. All the tubercles are imperforate and non-crenulate, and stand on a thin base. The long diameter is 32 millim., and the short 2 millim. less. Height 19 millim., peristome 12 millim., periproct 3 millim.

Only one, much altered specimen, was seen by MM. d'Archiac and Haime; but the examination of the specimens from the Nari series indicates that their diagnosis is correct in the main.

The following observations are recorded as the results of our study of the numerous specimens forwarded from India. They are taken in the order of the diagnosis given above:—

1. The shape is circular in outline actinally, but the projection of the ambulacra abactinally gives a pentagonal appearance which becomes less with age and size. The convexity above is well seen along the ambulacra.

2. The apical system is large. The periproct is oblique, its longest axis being in the direction of a line traversing ambulacrum No. 1 and interradium No. 3 (Lovén); it is rather large in relation to the diameter of the test. The basal (generative) plates are not quite equal in size, the madreporite being the largest; their outer edge is a blunt angle (about a right angle), and it projects decidedly into the interradium. The madreporite forms a sharper angle. The aboral edges of the plates form a raised ring around the periproct, and it carries a close row of large miliaries. Each plate has a prominent tubercle on it, and just external to it is the generative pore, which is large, a little external to central. The pore of the madreporite is nearer the margin of the plate. The radial (optic) plates are large; their inner or apical part is formed by two curved edges joining at a very open angle; their sides also curved, concavity outwards, slope, but so as to make the curved (concavity actinally) adoral edge broad; this broad curve has a minute central projection, and under it is the double optic pore. In some specimens the double foramen is visible a little way from the adoral edge on the surface of the plate. It is in a curved depression. The distance from the periproct-edge to the

actinal margin of the radial plate is nearly equal to that from the margin to the angle of a basal plate. The ornamentation of the plates consists, besides the miliaries already noticed, of others which are on either side of the tubercle on the basals, and a group on the radial plates. Ridges pass from the great tubercle outwards and downwards, cross the basal plate, and reach the radial and pursue the same direction.

3. The width of the ambulacra is not much more than one half of that of the interradia at the ambitus, and this is very characteristic. The tubercles reach up nearly to the radial (optic) plate.

4. The pores are large and circular, and the pairs very distinct; the poriferous zones form a wide angle at the radial plate.

5. In large specimens there are 26 tubercles on the interporiferous area, with three pairs of pores to the 13 large tubercles on either side of the median line; the intrusion of the pores into the scrobicular circle is common to this and other species (Fig. 10). The lower pair of pores of the triplet is nearer the median line than the others; and in well-preserved specimens the pairs are separated by a surface on which there is a row of three small miliaries; the pores are non-conjugate. The arrangement of the ambulacral plates is as in all *Cœlopleuri*. The large tubercle has a sutural line which passes on to and up it close to the mamelon from the upper pair of pores; it then suddenly turns abactinally, and reaches the abactinal edge of the plate. A corresponding line passes from the middle pair on to the tubercle; it does not touch the other, however, but curves actinally to reach the actinal edge of the plate. Hence a space exists between these two sutural lines, and comprehends the space between the middle pair and the upper pair of pores, the mamelon on the top of the tubercle, and all the plate towards the median line. There are thus three plates to each tubercle-bearing plate—one abactinal, small; one actinal, nearly of the same size and shape: and one between these, narrow at the top of the tubercle but comprehending the mass of the plate. The small plates are demi-plates and do not reach the median line, but the middle plate is great and does so. The third pair of pores has its adoral pore on the actinal line of suture of the lower small plate. (Fig. 12, and see Fig. 7: these drawings are semi-diagrams.) The imperfect union of the sutures shows that plates 1 and 3 are intercalated on the large plate 2 of the triple combination. Near the peristome the pairs of pores become small and more oblique.

The peristomial cuts are visible and small: a tag passes abactinally close to the poriferous zone, which is long and narrow, and is crossed actinally by ridges and grooves.

6. The median line of the ambulacrum, narrow in the extreme from the size of the bases of the bosses, has a row of miliaries on it, but actinally at the angles of the sutures in the median line there are fossettes, which vary in size and depth, and may not be present.

7. The interradia, bare abactinally to the sixth plate from the generative plate, are slightly concave there on the median line, and this part is bounded laterally by a rather broad edge which carries a vertical row of secondaries separated by miliaries, which also are seen beyond and near the pores of the ambulacra. At about the fifth

plate the vertical row of secondaries has a second one between it and the pores. The obliquity of the direction of the three secondaries explains the singularly oblique shape of the coronal plates (Fig. 12, in which the outlines of the plates are shown without these secondary tubercles). At the ambitus these vertical secondaries are in three rows. Each row is oblique; the largest secondary, very much smaller, however, than the primary, is close to it, and the other two form a close line near the actinal and outer edge of the plate. There may be only two secondaries, but in large forms there are three at the side of the largest primaries. More actinally there are only two, and near the radial plate only one. Above the oblique line of secondaries is a crowd of miliaries at the ambitus, and this diminishes actinally. In the median line, from the ambitus adorally, there are two rows of miliaries with an occasional third, and the miliaries pass along the horizontal sutures as well here and there. Above the ambitus the ornamentation is of large open zigzag grooves.

There is no doubt that *Cœlopleurus Pratti* is distinct from *Cœlopleurus equis*; and that the numerous secondary tubercles on the outer part of the interradial plates, with the miliaries above and below them and in the median line also below the ambitus, distinguish this species from *C. equis*. The narrow ambulacra are very distinguishing.

But when *Cœlopleurus Forbesi*, d'Arch., of the Miocene, is compared with *C. Pratti* all sorts of difficulties arise, and principally because, like many of MM. d'Archiac and Haime's species, it is founded on a solitary specimen which we should pass by as unworthy of notice. This species will be considered in dealing with the Gáj Echini in the next Fasciculus, and it is only necessary to remark that a worn and very probably derived specimen is in the Nari collection.

Dimensions. Height 15, breadth 27 millim.; height 17, breadth 31 millim.

Others measure: height 17 millim., breadth 34 millim.; height 13 millim., breadth 26·5 millim. These are more depressed than the type of d'Archiac and Haime.

Localities. Nari or Oligocene series of Sind. West side of Bhagothoro Hill, south of Sehwan. Hindi Hill. Survey-numbers G $\frac{226}{76}$, G $\frac{201}{67}$.

Illustrations of the Species in Plate XXXIX.

Fig. 9. The abactinal view of the test.

10. The ambulacral and interradial areas at the ambitus: magnified.

11. Apical system: magnified.

12. Semi-diagram of the oblique interradial plates and of the direction of the ambulacral sutural lines: magnified.

Order **ECHINOIDEA EXOCYCLICA.**

Suborder GNATHOSTOMATA.

Family CLYPEASTRIDÆ.

Subfamily EUCLYPEASTRINÆ.

Genus CLYPEASTER, *Lamarck*, 1801.

1. CLYPEASTER SIMPLEX, *Duncan & Sladen.* Plate XL, Figs. 1 & 2.

The test is pentagonal in outline, with the posterior angles truncated and the anterior angle rather acute; the lines of the sides are slightly inclined to the posterior angle, and the posterior edge is nearly straight and rather narrow.

The length is greater than the breadth, and the test is depressed, rising gradually from the rather sharp margins to the apex. Actinally there is considerable concavity, and the ambulacral lines there are well marked. Peristome not visible. Periproct small and near the edge. The petals are broad and long, hardly tumid, and rather tend to close. They are equal in length and extreme breadth *inter se*, and the only distinction is that the anterior is perhaps ·5 millim. the longest; their shape does not differ, and none are swollen.

The poriferous zones are broadest in the outer third, and diminish rather rapidly; they tend to close, and the left anterior (zone *b*) overlaps slightly the right one (zone *a*). The closing is not perfect in any one. The outer pores are the largest, and are more elliptical than those of the inner row.

Dimensions. Length 64·5 millim., breadth 59 millim., height 15 millim.

Locality. Nari series (Oligocene). Báran-River section, eight miles below Tóng. Survey-number G $\frac{220}{64}$.

Illustrations of the Species in Plate XL.

Fig. 1. The test, from above.
2. Longitudinal outline of test.

2. CLYPEASTER, sp. Plate XXXIX, Figs. 13 & 14.

Some small specimens of *Clypeaster* of the *Clypeaster-depressus*, Sowerby, type, but differing somewhat from that species, are in the collection. They are not sufficiently preserved to describe fully, and therefore we have drawn what can be seen.

Localities. Nari (Oligocene). Báran-River section, eight miles below Tóng, and from a high bed: and Trak, seventeen miles south of Búla Khán. Survey-numbers G $\frac{220}{62}$, G $\frac{220}{54}$.

Illustrations of the Species in Plate XXXIX.

Fig. 13. A specimen, abactinal view.
14. The same, from the actinal surface.

3. **Clypeaster monticulifera**, *Duncan & Sladen*. Plate XL, Figs. 3 & 4.

A *Clypeaster*, elliptical in shape, with a decided boss in the position of the apical system, and subequal widely open ambulacra, and a concave actinal surface.

Locality. Nari series. West side of Bhagothoro Hill, south of Sehwan. Survey-number G $\frac{220}{76}$.

Illustrations of the Species in Plate XL.

Fig. 3. The test, from above.
4. Longitudinal outline.

Suborder ATELOSTOMATA.

Family CASSIDULIDÆ.

Subfamily ECHINOLAMPINÆ.

Genus ECHINOLAMPAS, *Gray*, 1825.

The Nari series contains many species of this genus, and some are small and others are large forms. Although depressed in height, these last cover in some instances a greater area than any hitherto known forms.

1. **Echinolampas difficilis**, *Duncan & Sladen*. Plate XL, Figs. 5–7.

The test is irregularly oval in outline, rounded in front, broader behind the antero-lateral ambulacra than in front of them, broadest at about two thirds of the length from the posterior zone of the antero-lateral ambulacra to the anterior zone of the posterior ambulacra, and it narrows thence to the median line behind, being slightly nipped-in. The margins are rounded, tumid in front and at the sides, and become thinner at the posterior ambulacra and behind.

The test is rather low, has its highest point nearly central, and slopes gradually and very nearly equally to the front and backwards.

The apical system is slightly excentric in front, about one fifth of the whole length; it is on the anterior slope of the test. The disk is large, the pores of the anterior basals (generative pair) are closer together than the posterior, and the madreporic body is broad behind.

The petals are rather blunt at the apex, are long, with slightly sunken poriferous zones and faintly tumid interporiferous areas. They show very slight indications of closing, and are unequal in size.

The anterior ambulacrum, the shortest and slightly the narrowest, is lanceolate in outline, and the poriferous zones keep widely open to the end. The right zone (*a*) is the shorter of the two. As is the case with the other zones, they are narrow and about one half of the breadth of the interporiferous area. The pores are large, the inner are smaller and circular in outline, and the outer broadly and elongately comma-shaped. They are in a wide groove, and each pair is separated by a well-developed costa carrying a row of small miliaries.

The antero-lateral petals are very wide apart, are long, open, and the anterior poriferous zone is straighter than the other (*b*), which is curved. Both of these zones become narrow towards the adoral end, the anterior is the shortest, and the last pairs of pores of the posterior (*b*) curve slightly backwards.

The posterior ambulacra, the longest, are slightly sinuous near the apex, then straight and open; the poriferous zones become narrower towards the margin and are of equal length.

The ornamentation of all the interporiferous areas is of the same size as that of the interradia, but is closer. The lateral interradia are the largest.

The actinal surface of the test is depressed from the centrally placed peristome to about two thirds of the distance to the margin, where a tumid condition occurs, so that the test rests on a surface within the margin, which overhangs.

The peristome is large and pentangular in outline, and its breadth is not much greater than its length. The anterior bourrelets are distinct and large, and covered with a tuberculation which diminishes in size towards the inner part; the lateral are smaller, and the posterior (the broadest) is not so prominent as the anterior. The phyllodes are not very distinct, but they are slightly petaloid, narrow, tuberculate, and marked with the usual poriferous depressions, but not with extra plates. All around the peristome, beyond the bourrelets the ornamentation is large, and larger than elsewhere. Beyond this area of large ornamentation the tubercles become crowded and smaller to the margin, where they are only slightly more crowded than abactinally. The ornamentation between the margin and the apex consists of tubercles in sunken scrobicular areas surrounded by a raised margin, which is more or less finely granular.

The periproct is about as broad as the mouth, is infra-marginal and transversely elliptical, being much broader than long.

Dimensions. Length 59 millim., breadth 53 millim., height 19 millim.; distance of apical disk from anterior edge 24 millim. Relative length to breadth 1 : 0·98; relative length to height 1 : 0·32.

Locality. Nari series. Neighbourhood of Laki. The fossilization is the same as some specimens of *Cœlopleurus equis.* Survey-number G $\frac{280}{49}$.

Illustrations of the Species in Plate XL.

Fig. 5. The abactinal surface.
6. The actinal view.
7. Side view.

2. ECHINOLAMPAS D'ARCHIACI, *Duncan & Sladen.* Plate XL, Figs. 8 & 9.

The test is long, ovoid, depressed, tumid in front, nipped-in and sharper behind. It is longer than broad and broader than high, the relative proportions being length 1, breadth 0·87, and height 0·43.

The highest point is excentric in front, slightly in the rear of the apical disk; thence the test slopes boldly in front and gradually posteriorly, there being a comparatively level surface behind the apex and then a sharper descent towards the nipped-in projection over the periproct.

The apical system is very excentric in front. The anterior ambulacrum is short and narrower than the others, and is open distally. The antero-lateral ambulacra, very nearly transverse, are not very long, have a tendency to close, for the longer posterior poriferous zone curves towards the other, but still the ends are widely apart. The posterior zones do not reach more than three fourths of the distance to the margin, are open at the end, and the poriferous zones are equal. The posterior ambulacra are the longest and broadest.

All the poriferous zones are well developed, very slightly sunken, are rather more than one half of the breadth of the interporiferous areas, and have large outer comma-shaped pores and smaller inner ones which are circular in outline. On the lateral ambulacra there is much obliquity of the pairs of pores. The costæ are well developed, and have the usual row of miliaries on them.

Actinally the more angular posterior part of the test contrasts with the rounded anterior margin; the greatest breadth is seen to be at a bulge anterior to the postero-lateral ambulacra. The test is flattened above and behind the periproct, which is large, inframarginal, curved in front, straight behind.

The actinal surface is depressed around the central peristome. The ornamentation is rather large, is nearly equal from the margin to the apex, but is much larger around the peristome.

Dimensions. Length 57 millim., breadth 51 millim., height 25 millim.; distance of apical disk from front 23 millim. Relative length to breadth 1:0·877; relative length to height 1:0·43.

Locality. Nari series. Neighbourhood of Laki. Survey-number G $\frac{210}{40}$.

Illustrations of the Species in Plate XL.

Fig. 8. The abactinal view.
9. The side view.

3. Echinolampas Radakensis, *Duncan & Sladen.* Plate XL, Fig. 10.

The test is oval in outline, broadest on a line with the slightly excentric in front apical system, longer than broad, broader than high, depressed, tumid at the anterior and the lateral margins, and it rests on a surface between them and the excentric in front peristome. The apical system is small, and the ends of the ambulacra there are pointed and rather close. The anterior ambulacrum is rather tumid, is much the shortest and much the narrowest; it is open, but the poriferous zones tend to close, the right being the longest; the poriferous zones are narrow and the pairs of pores are crowded. The interporiferous area is tumid.

The antero-lateral ambulacra are petaloid and very wide apart; both poriferous zones are curved and narrow. The anterior is the shorter, and there is a tendency to close. The interporiferous area is broad and tumid, and three times the width of the poriferous zone. The postero-lateral ambulacra are tumid, rather longer than the others, and broader; they are petaloid, and tend to close by the approach of the ends of the poriferous zones, of which the posterior is the shortest. The peristome is narrow and pentagonal, the anterior bourrelets being well developed, and the phyllodes are rather petaloid. The tuberculation is very small and crowded on the actinal surface, and is larger abactinally.

Dimensions. Length 71 millim., breadth 60 millim., height 20 millim.

Relational dimensions. Length 1, to breadth 0·84, to height 0·28.

Locality. Nari series, Oligocene of Sind. Near the base of the group, near Rádak, ten miles S.S.E. of Jhángára. Survey-number G $\frac{322}{4}$.

Illustration of the Species in Plate XL.

Fig. 10. The abactinal surface.

There are many specimens of a species of *Echinolampas* in the collection from the Nari series which may be associated with *Echinolampas discoideus*, d'Archiac. The species is a very variable one and difficult to define; and, indeed, all the species of the genus *Echinolampas* from the Nari series have a facies in common, whatever may be their size.

4. ECHINOLAMPAS DISCOIDEUS, *d'Archiac*. Plate XLI, Figs. 1 & 2.

We give a summary of the description of the species by its authors, and then remark on the definition afterwards.

Test subcircular, a little longer than broad; no angular tuberosities on sides. Margin rounded. Slight projection above the anus. Apical summit slightly projecting at the anterior two fifths of the great diameter. Four genital pores rather small.

Petals long, flat, almost as open as in *Conoclypeus*, rather broad, and almost *unequal* amongst themselves in this respect. The two posterior are broader than the antero-lateral, and the odd ambulacrum is the narrowest. The antero- and postero-lateral ambulacra very slightly bent at the apex.

Poriferous zones rather broad, subcostulate, almost equal in the same ambulacrum. Interradial areas unequal; measured half way down the petals, the posterior is the broadest and the anterior are the narrowest, but near the apex these last are broader than the lateral.

Actinal surface subplane, slightly sunken in the middle.

Peristome nearly central; buccal tuberosities moderately pronounced.

Periproct inframarginal, small, and tolerably regularly elliptical in shape.

Tubercles small, close, especially at the margin, slightly unequal, principally on the ambulacra. Those near the peristome are larger than the others.

Length 7·6 centimetres, breadth 7·3, height 3·3.

Length 7 ,, breadth ? , height 2·8.

The types chosen by d'Archiac (described in 'Les Animaux fossiles de l'Inde,' p. 209) were well crushed from above downwards; and his drawing shows that the posterior half of the actinal part of the test is more tumid than the anterior; but taking the above measurement as nearly correct, the relative dimensions of length to breadth and height are :—Length to breadth 1 : 0·96 ; length to height 1 : 0·43.

With regard to this description given by d'Archiac and Haime, it is to be observed that the posterior interradium and the antero-lateral are subequal at the half-way point, and that the measurement on the type is accompanied by deformation of the test. The position of the apical system is incorrectly given, being too far forward ; the ends of the petals are exceedingly indistinct in the type, and the poriferous zones are not equal. The bent condition of the petals at the apex is incomprehensible. The poriferous zones are not broad. The tubercles are not close and small.

In fact the types chosen by d'Archiac were not only injured but worn, and were not full grown.

The most perfect specimen of the species *Echinolampas discoideus*, d'Archiac, in the collection from the Nari series, is not crushed, and is therefore normal in height.

It has the specific characters, and it is to be noticed that the madreporite separates the postero-lateral radials (ocular plates), that the posterior poriferous zone of the antero-lateral ambulacra is sinuous or slightly doubly curved, being moreover longer than the anterior zone, and that these ambulacra do tend to close. The posterior ambulacra are widely open.

There is an evident greater tumidity of the test behind the apex than over the region of the anterior ambulacrum, where there is some flattening.

The above-mentioned specimen measures 89 millim. in length, and is 83 millim. in breadth. The height is 36 millim. The relative dimensions are: length to breadth 1 : 0·93 ; length to height 1 : 0·41.

Locality. Nari series (Oligocene). Trak Hill, seventeen miles south of Búla Khán. Survey-number G $\frac{226}{87}$.

Illustrations of the Species in Plate XLI.

Fig. 1. The abactinal view.
2. The side view.

A second specimen, smaller than the preceding, is broader and higher relatively. Length 78 millim., breadth 74 millim., and height 35 millim. Relative dimensions :—length to breadth 1 : 0·94 ; length to height 1 : 0·46.

5. Echinolampas discoideus, *d'Archiac*, var. *α*, *Duncan & Sladen.* Plate XLI, Figs. 3–5.

A large specimen, 113 millim. long and 105 millim. broad, is 54 millim. high, and its relative dimensions are nearly those of the specimen we consider our type of *Echinolampas discoideus.*

It presents a decided flattening of the front margin, which becomes very decided in larger specimens, measuring 126 millim. long ; and the relative proportions are—length to breadth 1 : 0·93, and length to height 1 : 0·42.

Locality. Nari series (Oligocene). Northern end of Watwáro range, between Trak and Damaj. Survey-number G $\frac{302}{77}$. Trak Hill, seventeen miles south of Búla Khán. Survey-number G $\frac{226}{87}$. Hindi Hill, north of Trak. Survey-number G $\frac{303}{87}$.

Illustrations of the large Specimen with anterior truncation in Plate XLI.

Fig. 3. The actinal surface: natural size.
4. The peristome of another specimen: natural size.
5. Outline diagram of the peristome.

6. **Echinolampas discoideus**, *d'Archiac*, var. β, *Duncan & Sladen.*

This variety of the species is small and flat, and in one the length is 50 millim. breadth 53 millim., and height 19 millim. Relative length to breadth 1 : 0·98, and length to height 1 : 0·32.

The next variety, also a flat one, is thus described by us:—

7. **Echinolampas discoideus**, *d'Archiac*, var. γ, *Duncan & Sladen*[*].

The test is depressed, ovoid, broadest on the posterior half; it is longer than broad in a slight degree, and much broader than high. The relational proportions are: length 1, breadth 0·9, height 0·38.

The highest point is central, and behind the excentric in front apical system. The test slopes rather flatly, but with a gentle curve to the front, and much more boldly, and with some tumidity, posteriorly. The margin is nowhere tumid, but more swollen and rounded posteriorly than anteriorly. Actinally the peristome is central and sunken, the test being slightly tumid between it and the margins; there is some convexity between the peristome and the inframarginal, elliptical periproct, which is close to the posterior edge. The fore part of the actinal surface dips down slightly, and the test rests on a surface close to the anterior margin, and elsewhere between the peristome and the margin.

The excentric in front apical system is small and with rather large generative pores; the anterior are the closest, and all are oblique.

The odd ambulacrum is, as are the others, flush with the test, the poriferous zones being barely sunken. The interporiferous area is lanceolate, widely open at the end; and the poriferous zones, narrow and long, show no tendency to close; they are of the same length, and are slightly narrower at their termination. This ambulacrum is as long as the longest poriferous zone of the antero-lateral ambulacra, and only a little shorter than the postero-lateral ambulacra. The breadth of the odd ambulacrum, like that of the others, is not great, but it equals that of the posterior, although it is very slightly less than that of the antero-lateral pair.

The antero-lateral ambulacra, nearly transverse, are widely open, and the posterior poriferous zone is more bent than the anterior. They extend close to the margin. The postero-lateral ambulacra are slightly sinuous, long and open; the anterior zone is the longest. The poriferous zones generally are narrow, 2½ times less than the interporiferous areas. The ornamentation of the interporiferous areas is slightly smaller than that of the interradia; it is not crowded in these last. The actinal ornamentation is larger than the abactinal, and is very large in the posterior interradium. The anterior bourrelets are well developed.

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[*] We retain the specific name given by MM. d'Archiac and Haime without modification.

Length 67 millim., breadth 61 millim., height 26 millim.

Locality. Nari series, Oligocene of Sind. Mal-Mohári, west of Júngsháhi. Survey-number G $^{302}/_{78}$.

Dimensions of the Series of Forms of *Echinolampas* coming within the species *Echinolampas discoideus*, d'Archiac.

	Length. millim.	Breadth. millim.	Height. millim.	Length to breadth.	Length to height.	
1. Form	89	83	36	1 to 0·93	1 to 0·41.	Type.
2. Form	78	74	35	1 to 0·94	1 to 0·46.	Type.
3. Form	113	105	54	1 to 0·93	1 to 0·4.	Var. α.
4. Form	126	117	53	1 to 0·93	1 to 0·42.	Var. α.
5. Small specimen .	59	53	19	1 to 0·98	1 to 0·32.	Var. β.
6. Another	67	61	26	1 to 0·9	1 to 0·38.	Var. γ.

8. ECHINOLAMPAS PLACENTA, *Duncan & Sladen.* Plate XLII, Figs. 1–3.

The test is large, nearly as broad as long, very depressed, nearly circular in outline, but slightly nipped-in and produced behind, and slightly flattened over the inframarginal periproct. The margins are rounded rather sharply, and the highest point of the test is slightly excentric in front at the apical disk. There is a sharper slope in front than behind the apical system, and some flattening occurs over the anterior ambulacrum. But in spite of the flattening, the anterior margin is more swollen than the posterior (Fig. 3). The actinal surface has a gradual slope to the central peristome.

The apical system is flat and rather large, the madreporic body occupying the space between the four well-marked generative pores, and extending behind the line of the two posterior so as to separate the radial (ocular) plates of the posterior ambulacra. The ambulacra come to visible points beyond the madreporite, and the radial (ocular) plates are rather large. The ambulacra (anterior part of odd one is missing) are long, extend close to the margin, are open widely, are flush with the test, and are broad with comparatively narrow poriferous zones, which are unequal in the same ambulacra to some extent.

The narrowest ambulacrum is the anterior, and the longest and broadest are the postero-lateral ambulacra. The pores are rather large, the outer one elongate comma-shaped, and the inner nearly circular in outline; and the costæ, moderately broad, have a row of miliaries on them. The pairs narrow towards the distal end. The antero-lateral ambulacra, very wide apart, have the anterior poriferous zone nearly straight, except close to the marginal end, where there is a slight curving backwards and obliquity of the pores; the posterior zone is curved and sinuous, for distally the curve alters and the concavity is backwards; and this is the larger zone of the two. The posterior ambulacra have the anterior poriferous zone more bent than the other, but it is the shorter of the two. The peristome is small, pentagonal, broader than long, and widely open. The floscelle is well developed, the phyllodes are distinct, the antero-lateral in grooves, and there are some extra plates, and most of the pores are double.

The anterior bourrelets are somewhat tumid, as are the lateral, and the posterior is flat and the largest. The periproct is broader than the peristome, is close to the margin, and is elliptical with sharpish sides, and the anterior margin is more curved than the posterior.

The ornamentation of the interporiferous areas, abactinally, is very distinct, not crowded, and consists of sunken tubercles and intermediate granulated structure. It is slightly smaller than the ornamentation on the interradia, which is rather more distant. It becomes coarse and crowded at the margin from the narrow and projecting intermediate tissue, but it increases in size, distinctness, size of intermediate tissue, and granulation towards the peristome. It becomes small again on the inner slopes of the bourrelets. Small behind the periproct, it is larger anteriorly to it.

Dimensions. Length 115 millim., breadth 106 millim., height 40 millim.

Relative dimensions. Length 1, to breadth 0·92, to height 0·35.

Locality. Nari series (Oligocene). Pókhran, 50 miles S.S.W. of Sehwan. Survey-number G $\frac{220}{91}$.

Illustrations of the Species in Plate XLII.

Fig. 1. The test, abactinal view.
2. Actinal view.
3. Lower longitudinal section.

A second specimen is flatter, and has the posterior interporiferous areas narrower than the type just noticed, otherwise they are identical. Length 105 millim., breadth 99 millim., height 35 millim. The relative dimensions are:—length 1, to breadth 0·94, to height 0·33.

9. ECHINOLAMPAS TUMIDA, *Duncan & Sladen.* Plate XLIII, Figs. 1–5.

The test is very large, slightly longer than broad, not quite circular in marginal outline. It is about half as high as broad, very tumid at the margins, and swollen actinally; the peristome, which is rather excentric in front, being in a shallow broad depression. The highest point of the test is in front of the centre, and is at the apical disk; and the test slopes suddenly and boldly from that spot to the tumid anterior margin, and much more gradually backwards to the sharper margin over the periproct. The whole of the front of the test presents a very convex and massive appearance. But the upper part of the test is not rounded off equally with the flanks, and is more or less conical. The posterior margin slopes upwards and backwards from the actinal surface, so that the inframarginal periproct is seen slightly from behind.

The apical system is small. The ambulacra are long, but do not extend close to the margin; broad, with rather narrow poriferous zones which are nearly equal in each ambulacrum. There is a slight tendency to close in the antero-lateral ambulacra, and the poriferous zones of the postero-lateral are a little closer together at their extreme ends than midway; but the anterior ambulacrum is widely open. All the interporiferous areas are flush with the test and the poriferous zones also.

The anterior ambulacrum is long, lanceolate, and shows no tendency to close; its poriferous zones are equal in length, and the breadth of the two combined is rather less than that of the interporiferous area. The larger pores are of considerable dimensions; those which are at the distal end are subequal and nearly circular or elliptical in outline, but the outer pores become more and more elongate and straight comma-shaped towards the middle of the ambulacrum; thence they become gradually smaller. The inner pores are more elliptical than circular in their outline, and are smaller than the others. There is a very decided obliquity of the pairs of pores, which is produced by a slope of the outer part of the ambulacral plate; and the costa between the pairs of pores is wide and short, and carries more than one row of minute miliaries arranged in rather a confused manner. There is but little narrowing of the poriferous zones towards their termination. This ambulacrum is the shortest and narrowest, and its length is 52 millim. and greatest breadth 11 millim.

The antero-lateral ambulacra are broader and longer than the anterior one; the poriferous zones become narrow towards their end, and the anterior, the shortest, has its terminal pair of pores curved backwards; it is the shorter by about five pairs. Neither of the zones is much curved. The length is 56 millim., and the greatest breadth 12 millim.

The postero-lateral ambulacra are very long, 65 millim., and as broad as the antero-lateral. There is slight difference in the length of the poriferous zones, which diminish in breadth towards the end, and only a slight disposition to close.

The ornamentation of the interporiferous areas is smaller than that of the interradia, is not very close, and is rather transverse. The tubercles are small, sunken, and separated by a well-developed raised area, which is minutely granular (Fig. 8). The costæ are broad, and have at least two rows of miliaries on them.

The peristome, broadly pentagonal, is slightly in front of the centre, and is surrounded by the tumid actinal surface; the breadth is greater than the length from before backwards, and the bourrelets are fairly developed. The phyllodes are not large, but there is doubling of some pores. The posterior lip is the broadest and flattest. The breadth is 12 millim.

The periproct is on the upper and backward slope of the margin, is broader than the peristome, and is an elongate ellipse with the anterior margin more curved than the posterior.

The ornamentation of the interradia, abactinally, resembles that of the interporiferous areas, and it is slightly the larger. It increases steadily and gradually in size from the margin to the peristome; the tubercles become larger, situated in deeper scrobicules, and the intertubercular ornamentation becomes larger, wider, and more distinct. The largest ornamentation is in the ambulacra near the peristome, and on the posterior lip a little remote from the mouth. In those localities the granular ornamentation between the tubercles is wide.

Dimensions. Length 117 millim., breadth 107 millim., height 64 millim.

Relative dimensions. Length 1, to breadth 0·91, to height 0·54.

Locality. Nari series (Oligocene). Trak Hill, 17 miles S. of Búla Khan. Survey-number G $\frac{226}{87}$.

Illustrations of the Species in Plate XLIII.

Fig. 1. The test, side view: natural size.
2. Actinal surface.
3. Part of anterior ambulacrum, showing obliquity of plate: magnified.
4. Ornamentation of ambulacrum: magnified.
5. Ornamentation of under surface: magnified.

10. Echinolampas tumida, *Duncan & Sladen*, Variety.

The test is circular in marginal outline, nearly hemispherical, tumid at the margins except in the posterior part of the test, and with a swollen actinal surface around a slightly sunken central peristome.

The highest point of the test is behind the apical system, which is rather excentric in front. There is some flattening of the test on either side of the anterior ambulacrum.

Apical system rather large. The ambulacra are long, slightly raised, widely open at the end; the poriferous zones of each ambulacrum are nearly equal, except in the postero-lateral; they become narrow gradually, and are less than one half of the breadth of an interporiferous area.

The pairs of pores are separated by well-developed costæ, with a single row of miliaries on them, and there is some obliquity of the poriferous part of the plate. The inner pores are smaller and more circular than the others, which are long and comma-shaped, where not much worn.

The anterior ambulacrum is very long, comes close to the margin, and is widely open. It is 49 millim. long and 1 centim. broad near its end. It is very slightly bent. The antero-lateral ambulacra are of the same length and breadth as the odd one; the posterior poriferous zone is the most curved and the longer; there is a slight tendency to close. The postero-lateral ambulacra are the longest and broadest, and the posterior zone is the longer.

The peristome is broad, and the floscelle developed. The periproct is close to the edge and inframarginal. The ornamentation of the ambulacra is rather small and of the same size as that of the interradia; the tubercles are separated by a miliary raised tissue. Actinally the ornamentation is large, and especially near the peristome.

Dimensions. Length 104 millim., breadth 101 millim., height 59 millim. Relative length to breadth 1 : 0·97; relative length to height 1 : 0·56.

Locality. Nari series (Oligocene). S.E. side of Trak Hill. Survey-number G $\frac{498}{77}$.

The circular marginal contour is very characteristic of this variety.

Family SPATANGIDÆ.

Genus EUSPATANGUS, *Agassiz*, 1847.

1. Euspatangus rostratus, *d'Archiac.* Plate XLIII, Fig. 6.

Some large forms of this *Euspatangus* are in the Nari series, and approach *Euspatangus affinis*, nobis, which was described in the memoir on the Fossil Echinoidea of Kachh and Kattywar (plate xii, fig. 2). The posterior nipping-in of the test is, however, very decided in the Nari forms; the number of large tubercles is considerable, and there is a fasciole on one part of the flank of the test, which is very distinct. It is not continuous, however.

Actinally the marginal tuberculation ends towards the posterior ambulacrum suddenly, and large tubercles come in. The bare space of the smooth plastron and ambulacra is dotted here and there with distinct miliaries, which are about the same size as those which are scattered between the large actinal tubercles.

Locality. Nari series (Oligocene). West side of Bhagothoro Hill, south of Sehwan. Survey-number G $\frac{226}{76}$.

Illustration of the Species in Plate XLIII.

Fig. 6. A large specimen, from above.

Genus SCHIZASTER, *Agassiz*, 1836.

SCHIZASTER GRANTI, *Duncan & Sladen*. Plate XLII, Figs. 4–6.

There are several specimens of the genus in the collection from Nari, but unfortunately their condition of preservation is unsatisfactory. It is evident, however, that *Schizaster Granti*, nobis, which is so largely represented in Kattywar, in strata higher than the Nummulitic, and which are Miocene in age, is present in the Nari series*.

Locality. Nari series (Oligocene). West side of Bhagothoro Hill, south of Sehwan. Survey-number G $\frac{226}{76}$.

Illustration of the Species in Plate XLII.

Fig. 4. The side view. (The fasciole is not seen in this specimen.)
5. The abactinal view. (Fasciole is worn.)
6. A linear longitudinal view of a large specimen.

In these figures the shape is given, and not the details.

IV. *Remarks on the Species.*

The *Cidaris* has a truly Sindian facies.

The *Cœlopleuri* belong to two species which have been described by d'Archiac and Haime as coming from the Nummulitic of Sind. These are *Cœlopleurus equis*, a European form, and *Cœlopleurus Pratti*, closely allied and only known in Western India.

The interest of these forms has been greatly increased by the descriptions of the living species by Alex. Agassiz.

In *Cœlopleurus Maillardi*, Mich., collected during the 'Challenger' Expedition, the spines, like those of the West-Indian species *Cœlopleurus floridanus*, are extraordinarily long; but in both species, as in the fossil forms, the tubercles are non-crenulate, showing that crenulation and size of spines and their power of movement are not invariably associated. In the first-named species the bare median interradial area is ornamented by a few flat, broad, inconspicuous miliaries, and by smooth broad bands, somewhat raised, forming irregular S-shaped lines extending from the centre of one plate to the upper edge of the following plate. These are seen more or less modified and in a greater degree in the fossil forms. The arrangement of the ambulacra and interradia is generally the same, but special distinctions are noticed in the recent and fossil species. In the fossil forms the ambulacra are prominent, and are relatively narrower than in the recent species.

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* 'Fossil Echinoidea of Kachh and Kattywar.' Pal. Indica, Ser. XIV. pp. 70 & 88, plate vi, figs. 8–12.

The ambulacral tubercles extend close to the radial (ocular) plates in the fossil forms and also in *Cœlopleurus Maillardi*; and the interference of the pairs of pores with the raised scrobicules of the large tubercles is greatest in the extinct species.

The median sutural pits near the actinal end of the ambulacra are visible in all the species, but they are certainly variable in the fossil forms and most developed in the recent West-Indian. They may be for sphæridia, as Agassiz suggests in the Report on the 'Challenger' Echini. The tag-like prolongation from the peristomial cuts is seen in all the species. The apical system differs, and the elliptical anal opening of the East-Indian recent form is represented by an obliquely-placed oval anus in the fossil species.

The ornamentation between the large interradial tubercles and the poriferous zone is different in the two fossil species, and is distinct from that of the recent forms. The construction of the triplets of the ambulacral areas is shown on Plate XXXIX, Figs. 7 & 12. It is most singular, and characterizes the genus. Nothing resembling it has hitherto been noticed.

The study of the Gáj and Kachh forms of *Cœlopleurus* has opened out many interesting points, and we are engaged in describing the anatomy of the recent species.

Clypeaster simplex from the Nari series is allied to the species of *Clypeaster* from the same geological horizon in Kachh, and its nearly equal petals are very characteristic.

Clypeaster depressus, Sow., is common in the Nari series and in the corresponding strata in Kachh, and it is therefore not a true Nummulitic form. It passes up into the Miocene.

The third species from the Nari series is not a very satisfactory one; but the humped nature of the apical area and a little beyond is characteristic. Actinally the form is very concave.

The Echinolampinæ from the Nari series are very characteristic and numerous. Some are very large forms indeed, and all are comparatively depressed, some very much so. They differ entirely in shape from those of the Nummulitic of Kachh and from those of the Miocene of that district and Kattywar. Their facies is altogether distinct from that of the large Echinolampad fauna of the Khirthar Nummulitic beds of Sind, where the flat, discoid, and subpentagonal forms of the Nari series have no representatives whatever; whilst, on the other hand, the elongate and regularly curved outlines of the characteristic Khirthar species stand closely distinguished from the Nari species of *Echinolampas*.

There is nothing very marked about the species *Echinolampas difficilis*, except its manifest alliance with *Echinolampas discoideus*, d'Archiac. The proportions, however, differ, and the general shape also. But its details help to maintain the generally depressed character of the Echinolampinæ of the Nari series and their alliances with *Echinolampas discoideus*. *Echinolampas d'Archiaci* is not unlike *Echinolampas Sindensis* at first sight; but the contour and the nature of the margin distinguish it.

Echinolampas Radakensis introduces the discoid series, and is one of the troublesome species which cannot be classified with better-known forms and yet have an indefinite individuality of their own.

Echinolampas discoideus, d'Archiac, is a very variable form, and, with its varieties, characterizes the Nari series. The specimen used by d'Archiac and Haime, which is in the collection of the Geological Society of London, is one which we should have declined to investigate as a specific type. We have carefully considered the measurements of it and of those in the collection from the Nari series, and we consider the form figured in Plate XLI, Figs. 1 & 2, to be the true *Echinolampas discoideus*. One of the most interesting varieties of the species is a large form which has the margin in front flattened. Fortunately, in one of the specimens the peristome is well preserved, and we have given a view of it. A third specimen shows a worn condition of the peristomial ambulacra, and its delineation (Plate XLI, Fig. 5) certifies to the correctness of Lovén's descriptions of the relative position of the tentacular orifices.

The great flat *Echinolampas placenta* is clearly one of the allies of *E. discoideus*. It is a most extraordinary form, especially when considered in relation to the great *Echinolampas tumida* from the same series. These species are among the largest of the genus, and appear to be confined to the Nari series.

Euspatangus rostratus, d'Archiac, appears to have a considerable vertical and horizontal range, and the species is found in Kachh. The Nari form certainly has some of the features of *Euspatangus affinis*, Duncan & Sladen, from Kachh.

Finally, *Schizaster Granti*, Duncan & Sladen, is found in the Nari deposits and is a common fossil in Kattywar. It passes up into the Miocene series.

The Oligocene strata of Sind and of Kachh are evidently worthy of the name, and the evidence of their intermediate position between the Eocene and the Miocene is offered by the study of the Echinoidea as well as of the Corals. Moreover, the horizon of the strata containing the fossils is not a low one in the series, and there is a slight community of species between the Nari and the overlying Miocene deposits.

V. APPENDIX.

THIS Fasciculus contains the description of the uppermost Nummulite-bearing rocks of Sind, and the next, which will be published shortly, will relate to the Miocene strata of the same province. As that Fasciculus will be the last of this Series, it will contain the necessary lists of the species of the Echinoidea, and also the remarks upon the affinities of the faunas of the consecutive great groups of strata. The affinities of the Nummulitic, Oligocene, and Miocene faunas of Sind will then be considered in relation to those of the equivalent European strata.

In concluding this part of our work it becomes necessary for us to introduce here some remarks which we have already published in the 'Annals and Magazine of Natural History' for October 1884.

A species of the genus *Hemiaster* (*H. elongatus*) was described by us in page 78 of the fasciculus on the Echinoidea of the Ranikot series, and it was figured on Plate XIX.

Professor Sven Lovén, in a masterly essay on the genus *Pourtalesia*, communicated to the Royal Swedish Academy of Sciences, June 1882, and which was published in 1883, stated in two footnotes, one on page 73 and another on page 79, that our species *H. elongatus* belongs to the genus *Palæostoma*. It is evident to us that if this is true, another species (*Hemiaster digonus*, d'Archiac) must come within the same generic environment. We have gone over the descriptions and drawings of both these species, and have compared them with the original types, and we still retain the forms in the genus within which they were placed by us.

The following extract from the 'Annals and Magazine of Natural History' for October 1884, p. 239, places our views definitely :—

"We may admit that the two species of *Hemiaster* differ equally from *Palæostoma*.

"In all the forms the apical system is small, and two of the generative plates, 1 and 4, have conical eminences, on which are the large ovarial pores.

"In all three forms the generative or basal plates 2 and 3 are small and without perforations for ovarial ducts, and here the structural similarity ceases. The genus *Palæostoma* has no madreporite passing back between the two perforated plates 1 and 4;

the other two forms have this, and, moreover, the madreporite reaches back between the posterior oculars I. and V. There are no sutures in *Palæostoma*, but they are present between all the plates in the forms we have called *Hemiaster*.

"The peristome of *Palæostoma* is pentagonal at all ages; that of our *Hemiasters* is never pentagonal, and is of the crescentic shape of the genus, the front edge being curved widely and the back lip being also curved and projecting downwards as a prominent structure. In *Palæostoma* the interradial plates *1* at the margin of the mouth are large, nearly equal in their considerable space, and the ambulacral plates contribute but slightly to the margin. In the other forms only the plate *1* of interradium 5 is large, and, as in all *Hemiasters*, the other first plates barely contribute to the peristome, whilst the greater part of the margin is made up of the ambulacral plates. The first interradial plates of 1, 2, 3, and 4, not very wide posteriorly in *Palæostoma*, are decidedly wide in the *Hemiasters*.

"There is a most remarkable heteronomia of the interradium 1 in *Palæostoma mirabile*, but there is nothing of the kind in the two other forms. They present the normal heteronomia of the interradia, actinally, which is usual to such Spatangoids. There is no plastron in *Palæostoma*, but there is in the other forms.

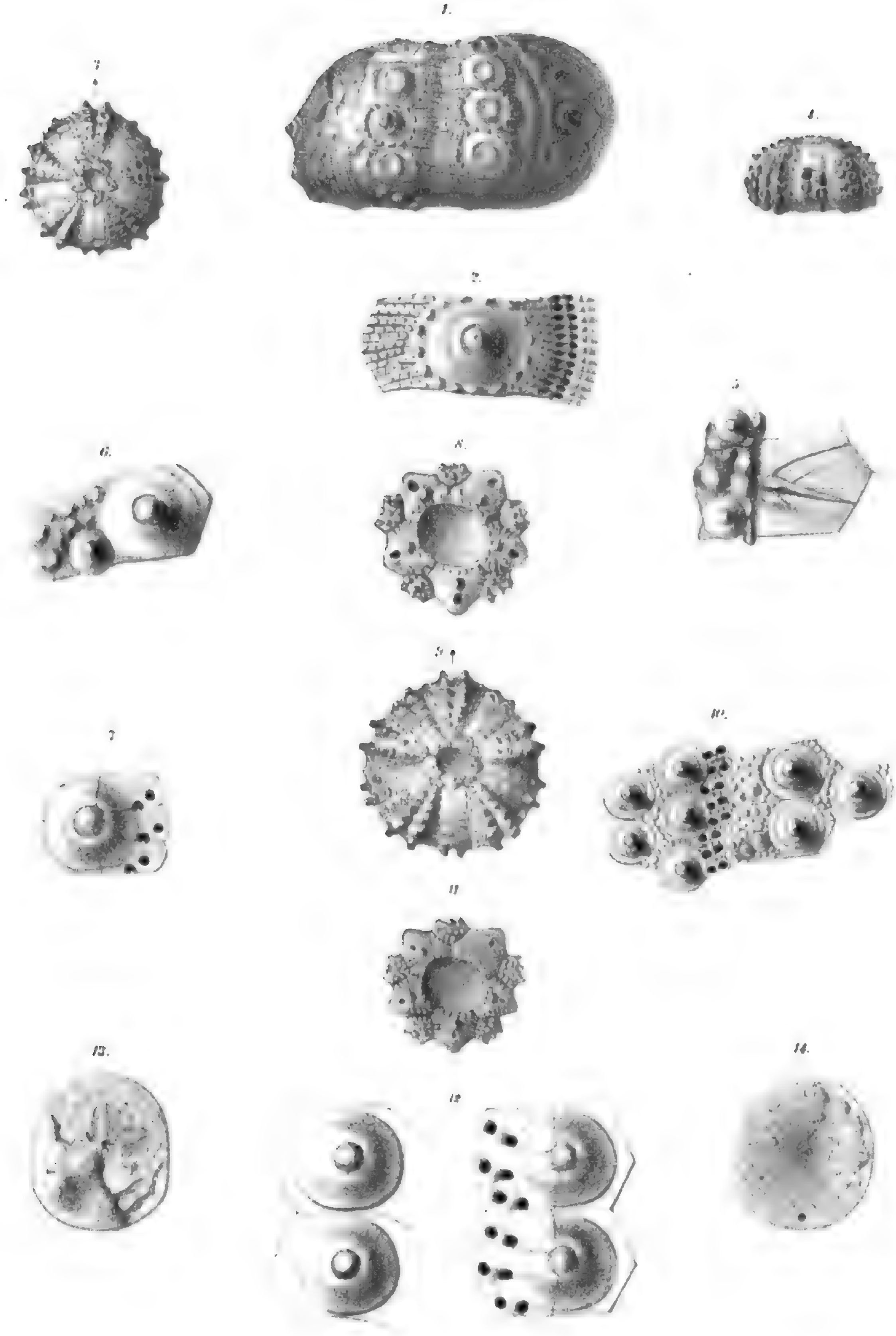
"The very broad ambulacra on either side of the odd interradium in *Palæostoma* are not characteristic of the *Hemiasters*; on the contrary, their ambulacra are narrow. In *Palæostoma* there is a remarkable enlargement of the fifth ambulacral plate of amb. 1. row *a*, and it is pushed to the left because plate *b 3* of interradium 5 is placed so much to the front of *a 3* of the same interradium that there is a vacant space. This is not the case in the two species which we have named *Hemiaster*, and plates *a 3* and *b 3* of the odd interradium are as is usual in the Spatanguids.

"We consider that we have proved that the generic characters of *Palæostoma* are not present in the form we named *Hemiaster elongatus*, nor are they in the closely allied species *H. digonus*, d'Archiac."

Since this reply was published, Professor Lovén kindly assents to our original determination. But he doubts the propriety of permitting so-called *Hemiasters* with only two generative pores and a backwardly passing madreporite to remain in the genus as established by Desor. (November 1884.)

PLATE XXXIX.

Figure 1. Cidaris. sp. (page 250). The test, natural size.
2. A coronal plate and part of an ambulacrum, magnified.
3. Cœlopleurus equis, Agassiz (page 251). The test, abactinal view.
4. Side view of the test.
5. Interradial plates; lower part of fourth and the whole of the fifth from the apex, magnified.
6. Interradail plate with tubercles at the ambitus, magnified.
7. Ambulacral triplet and tubercle (actinal surface), magnified.
8. The apical disk, magnified.
9. Cœlopleurus Pratti, d'Archiac (page 254). The test, from above.
10. Part of ambulacrum and interradium, at ambitus, magnified.
11. Apical disk, magnified.
12. Semi-diagram of the oblique interradial plates and of the direction of the ambulacral sutural lines, magnified.
13. Clypeaster, sp. (page 257). Abactinal view.
14. Actinal view.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Duncan & Sladen del. A. Gawan lith.

Mintern Bros. imp.

Fossil Echinoidea from Sind.
Nari Series (Oligocene)

PLATE XL.

Figure 1. Clypeaster simplex, Duncan and Sladen (page 257). The test, from above.

2. Longitudinal section in outline.

3. Clypeaster monticulifera, Duncan and Sladen (page 258). The test, from above.

4. Longitudinal outline.

5. Echinolampas difficilis, Duncan and Sladen (page 258). The test, abactinal view.

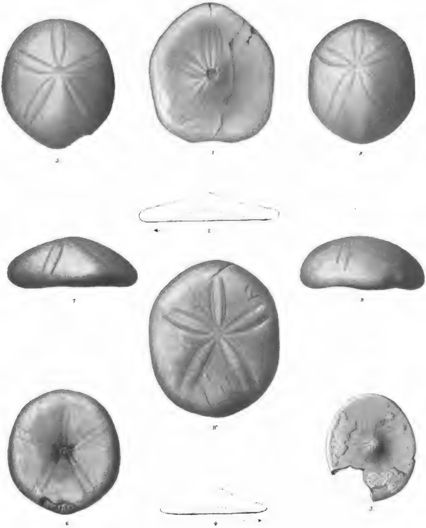
6. The actinal surface.

7. Side view of the test.

8. Echinolampas d'Archiaci, Duncan and Sladen (page 259). The test, abactinal view.

9. Side view.

10. Echinolampas Radakensis, Duncan and Sladen (page 260). The test, from above.



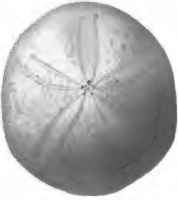
Duncan & Sladen dir. A. Gavan lith.

Mintern Bros. imp.

Fossil Echinoidea from Sind.
Nari Series (Oligocene).

PLATE XLI.

Figure 1. Echinolampas discoideus, d'Archiac (page 261).
2. Side view.
3. Variety a. Large specimen (page 262), truncated in front, actinal surface.
4. The peristome of another specimen, natural size.
5. The floscelle and peristome, semi-diagram, magnified slightly.



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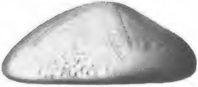

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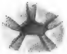

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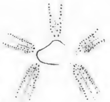

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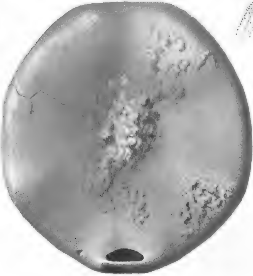

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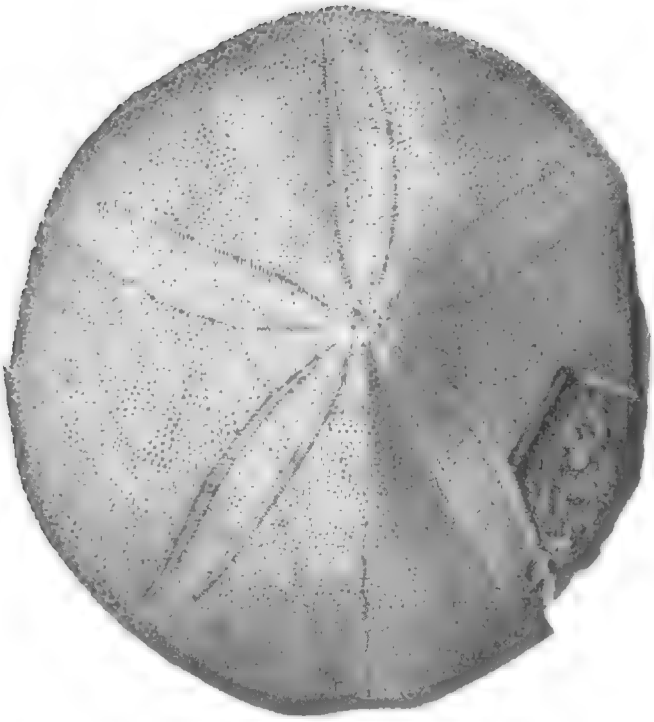
Dunger & Sladen del. A. Gamez lith.

Fossil Echinoidea from Sind.
Nari Series (Oligocene).

Mintern Bros. imp.

PLATE XLII.

Figure 1. ECHINOLAMPAS PLACENTA, Duncan and Sladen (page 264). Abactinal view.
2. Actinal view.
3. Linear longitudinal section.
4. SCHIZASTER GRANTI, Duncan and Sladen (page 268). Side view, showing shape, but not the details.
5. Abactinal view.
6. A large specimen, much worn, linear outline.



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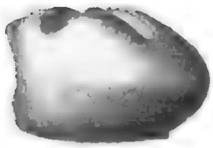

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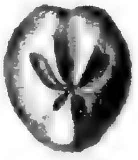

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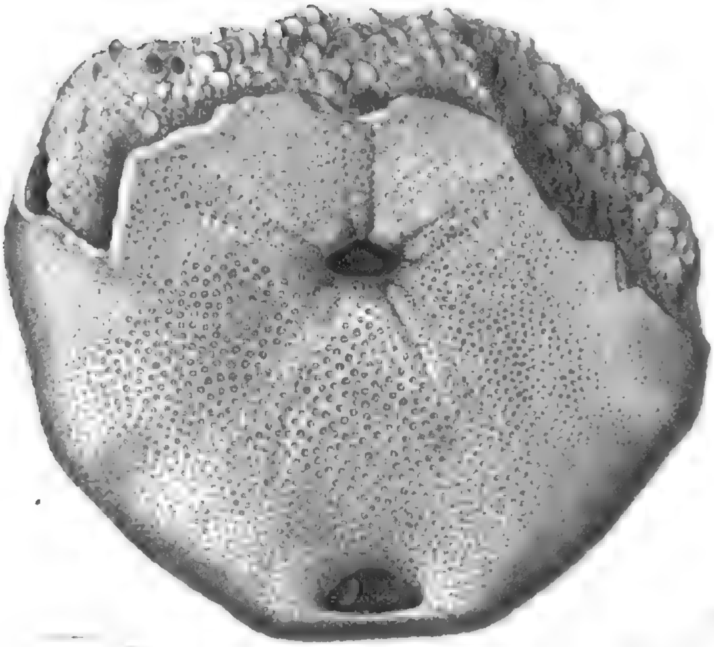

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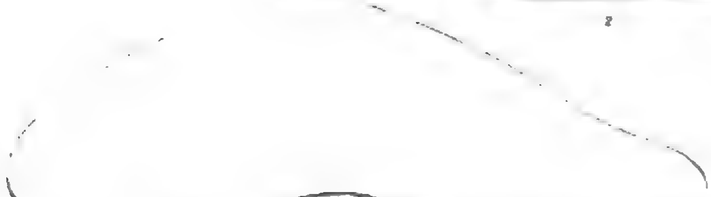

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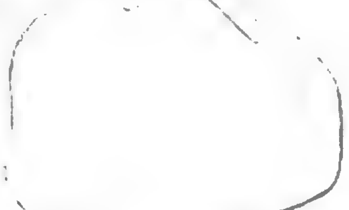

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Duncan & Sladen del. A. Gawthorn lith.

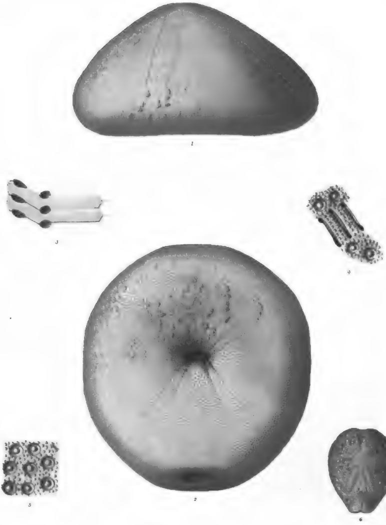
Mintern Bros. imp.

Fossil Echinoidea from Sind.

Nari Series (Oligocene)

PLATE XLIII.

Figure 1. **Echinolampas tumida**, Duncan and Sladen (page 265). Side view.
- 2. Actinal view, natural size.
- 3. Plates of anterior odd ambulacrum, worn, showing the obliquity of the poriferous zone, magnified.
- 4. Part of a poriferous zone, showing the ornamentation of the costæ, magnified.
- 5. Actinal ornamentation, magnified.
- 6. **Euspatangus rostratus**, d'Archiac (page 267).



Duncan & Sladen dir. [illegible] del.

Fossil Echinoidea from Sind.
Nari Series (Oligocene)

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MEMOIRS

OF THE

GEOLOGICAL SURVEY OF INDIA.

Palæontologia Indica,

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING
THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL.

TERTIARY AND UPPER CRETACEOUS FOSSILS OF WESTERN SIND.

Ser. XIV.

Vol. I. 3. THE FOSSIL ECHINOIDEA.

Fasciculus V. THE FOSSIL ECHINOIDEA FROM THE GÁJ OR MIOCENE SERIES.

WITH 12 PLATES.

BY

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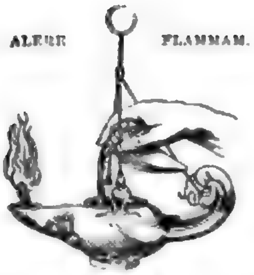
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A DESCRIPTION
OF THE
FOSSIL ECHINOIDEA
OF
WESTERN SIND.

FASCICULUS 5.—THE GÁJ SERIES (MIOCENE).

PLATES XLIV.–LV.

I. *Introductory Remarks on the Gáj Series.*

THE general relations of the Gáj series of Tertiary rocks of Western Sind were stated in the first part of this work, in the introductory remarks upon the positions whence the fossil Echinoidea of Sind were derived. An abstract was given of the nature of the succession of the Gáj series and also of the Nari series below and the Manchhar series above it.

This stratigraphical information was derived from the elaborate work 'On the Geology of Western Sind,' from the Memoirs of the Geological Survey of India, by W. T. Blanford, F.R.S.*, Deputy Superintendent of the Geological Survey. The survey of the area was the joint labour of Messrs. Blanford and Fedden, and the fossils which were collected under the superintendence of those gentlemen were sent to us from H. B. Medlicott, Esq., F.R.S., the Superintendent of the Geological Survey of India.

Geologists will find the descriptions of the strata and the physical geology of Western Sind, given in the memoir just noticed, full of interest, as illustrating the varied features of the very wonderful series of Tertiary deposits in Western India.

This memoir has been, moreover, carefully considered in the 'Manual of the Geology of India,' by Messrs. Medlicott and Blanford, 1879.

---

* Memoirs of the Geological Survey of India, vol. xvii. pt. 1 (1879).

The result of the examination and description of the Fossil Corals of the Gáj series[*] proved that it was on a higher horizon than the Nari series, and this has been confirmed by the study of the Echinoidea which we now offer to palæontologists.

In fact the deductions made by the geological surveyors in the field have been proved to be correct. The evidence which was obtained from the study of the Corals is confirmed by the examination of the Echinoidea, and indeed it may be said that although the Corals distinctly gave a Miocene horizon to the Gáj series, it was not a high one. Nevertheless the Echinoidea are indicative of a high horizon in the Miocene.

The following abstract of the description of the Gáj series from the 'Manual of the Geology of India,' pp. 463 *et seq.*, will be found useful:—

"*Gáj Group.*—Upon the Nari group, almost throughout Sind, there is found resting a mass of highly fossiliferous limestones and calcareous beds, usually more or less shaly, always distinctly stratified, and easily distinguished from the limestones of the older Tertiary formations by the absence of Nummulites. A superb section of the strata forming this group is exposed on the banks of the Gáj river, the only stream which cuts its way through the Khirthar range, and in the neighbourhood of which, west of the range, the fine section of Lower Tertiary and Cretaceous beds, already noticed, is exposed. From this river the present group derives its name.

"On the eastern flanks of the Khirthar range, in Upper Sind, the Gáj group forms a conspicuous ridge, the hard dark-brown limestone bands near the base of the formation resisting the action of denudation far more than the soft sandstones of the Nari beds, and rising every here and there into peaks of 1000 and 1500 feet, or even more, escarped to the westward, and sloping to the east, Amru (the highest summit of the Gáj ridge) being 2700 feet above the sea. Still the limestone bands, although so conspicuous, are subordinate, the greater part of the group consisting of sandy shales, clays with gypsum, and, towards the base, sandstones. Many of the bands of limestones appear very constant in position, and may be traced for a long distance. As a rule they are dark brown in colour; but one bed is white, and abounds in corals and small Foraminifera (Orbitoides), whilst some of the darker bands contain Echinodermata in large quantities. The uppermost portion of the group is usually argillaceous, being chiefly composed of red and olive clays with gypsum; and these beds pass gradually into precisely similar strata belonging to the overlying Manchhar group. The passage-beds contain, amongst other fossils, *Turritella angulata*, and forms of *Ostrea* and *Placuna*, and the following:—

Corbula trigonalis.	*Tellina subdonacialis.*
Lucina (Diplodonta) incerta.	*Arca Larkanensis.*

"All of these have allies living in estuaries at the present day, *Arca granosa*, a recent representative of *A. Larkanensis*, being one of the commonest and most typical of Indian estuarine Mollusca. To these estuarine passage-beds further reference will be made presently, when the relations of the Manchhar to the Gáj beds are discussed.

---

[*] Pal. Indica, Series XIV. vol. 1 (now 2), 1880. Sind Fossil Corals and Alcyonaria, P. Martin Duncan.

The Gáj beds at the Gáj river are very nearly 1500 feet thick, but they appear to be less developed to the northward in the Khirthar range, and not to be much more than half the thickness named west of Lárkána, where, however, they are nearly vertical, and have probably suffered from pressure. In Lower Sind the Gáj group, like the Nari, disappears to the eastward of the Laki range, where it is either entirely wanting or else represented by a thin band, containing one of the characteristic fossils, *Ostrea multicostata*, at the base of the Manchhar group. There is, however, a very large area of Gáj beds north and north-east of Karáchi; and the appearance of the formation there is somewhat different from what it is in the Khirthar range; for the greater portion of the group consists of pale-coloured limestones, almost horizontal, or dipping at very low angles, and to the east of the Habb valley forming plateaux 400 or 500 feet high, bounded by steep scarps, which rise from the low ground of the soft Nari sandstones.

"A low range of hills, formed of Gáj beds, extends to the south-west, past the hot springs at Magar or Mangah Pír, to the end of the promontory known as Cape Monze, west of Karáchi; and the same beds form the low hills east and north-east of the town, and furnish the materials of which the houses in Karáchi are mostly built. A small island called Churna, in the sea, west of Cape Monze, also consists of Gáj rocks. To the northward, the Gáj area of Lower Sind extends, with very irregular outline, to the neighbourhood of Tong and Karchat, almost due west of Hála; and there are several outliers farther north, connecting the southern portion of the group with the typical outcrop in the Khirthar range. East of Karáchi, also, Gáj beds extend in the direction of Tatta until they disappear with the other Tertiary rocks beneath the alluvium of the Indus. As was shown in a previous chapter, the Gáj group of Sind appears to be represented in Cutch by a highly fossiliferous belt, containing most of the typical mollusca, echinoderms, &c. It is quite possible that the present group, as well as the Nari, never was deposited in the neighbourhood of Kotri and Jhirak.

"It has been already stated that the Gáj beds, throughout the greater portion of the Khirthar range, rest conformably upon the Nari group, although there is a change in mineral character, and that in Lower Sind the passage from one group into the other is gradual, calcareous bands, with Gáj fossils (such as *Ostrea multicostata* and *Pecten subcorneus*), being found interstratified with the uppermost Nari sandstones. At one place, however, near Tandra Ráhim Khán, west by north of Schwán, the outcrop of the Gáj beds, here dipping at a high angle to the westward, runs nearly in a straight line across the mouth of a valley, composed of a deep synclinal of the Nari group, between two anticlinal ridges of Khirthar limestone. As the Gáj beds do not share the synclinal curve of the Naris, it is difficult to see how the two can be conformable; but an examination of the boundary between the two groups failed to show any clear evidence of unconformity. There are, however, some places south of Sehwan where the Gáj group overlaps the Nari beds and rests upon the Khirthar limestones; but it must be recollected that the Gáj group is itself overlapped by Manchhar beds in the immediate neighbourhood. The commonest and most characteristic fossils of this group are *Ostrea multicostata* and *Breynia carinata*."

It is very important to notice that there is another marine series of the Tertiaries in relation to the Gáj group.

The normal succession is that of the freshwater Manchhar beds, one of the Rhinoceridæ of which has been discovered in the Gáj beds. But **Blanford** has described the Makrán beds, and the following is an abstract of what is said regarding them in the 'Manual of the Geology of India,' p. 470:—

"*Relations to Makrán group.*—The Manchhar beds extend along the edge of the sea, west of Karáchi, almost to the end of Cape Monze; but no representative of this formation is seen for a considerable distance to the westward of the Cape. But west of Sommiani Bay, in the neighbourhood of Hinglaj, a well-known place of Hindu pilgrimage, there are high hills of hard greyish-white marls or clays, usually sandy, often highly calcareous, and occasionally intersected with veins of gypsum. With this clay or marl, bands of shaly limestone, dark calcareous grit, and sandstone are interstratified. This marl-formation extends for many hundreds of miles along the coast, and is well seen at Rás Malán, Ormára, &c., at the entrance of the Persian Gulf. The headlands of Rás Malán, Ormára, and Gwádar consist of great horizontal plateaux surrounded by cliffs of whitish marl or clay, and capped by dark-coloured calcareous grit, Rás Malán especially being a table-land rising abruptly to the height of 2000 feet from the sea. These remarkable rocks are called the Makrán Group. The Makrán group is purely of marine origin, and abounds in Mollusca, Echinoderms, &c., most of the species apparently being the same as those found in the neighbouring seas at present." The authors proceed to state that none of the characteristic Gáj fossils are found in the Makrán series, and that the latter deposit seems to be later than the Gáj. It is then noticed that some of the soft argillaceous beds of Manchhar age in the neighbourhood of Karáchi closely resemble some similar beds in the Makrán group near Gwádar.

The Echinodermata we have examined from the Makrán series certainly have a facies later in time than the Gáj collection.

Again the Makrán deposits, whence the Echinodermata we have examined came, are not the same thing as the so-called Littoral concrete of the coast to the north of Bombay, a deposit which is partly quite recent and partly since the Pliocene.

The succession of the series appears to have been as follows:—The Nari or Oligocene series, the Gáj Miocene, the Makrán beds, the marine equivalents of the Manchhar deposits, the Littoral concrete.

The importance of this succession is enhanced by the consideration that the Manchhars are of the same age as the Siválik deposits on the flank of the Himalayas, this great orographical system having attained its full development after the commencement of the Sivalik age. The great Post-pliocene disturbance is of great interest, both in the Himalayan region and in Sind.

II. *List of the Fossil Echinoidea from the Gáj Series.*

Order **ECHINOIDEA ENDOCYCLICA.**

Family CIDARIDÆ.

Genus CIDARIS, *Klein*, 1734.

Cidaris opipara, *Duncan & Sladen*: p. 279.
—— excelsa, *Duncan & Sladen*: p. 282.
—— spp. (spines): p. 283.

Family ARBACIADÆ, Gray, 1855.

Genus CŒLOPLEURUS, *Agassiz*, amended.

Cœlopleurus Forbesi, *d'Archiac & Haime*, amended: p. 287.
—— Sindensis, *Duncan & Sladen*: p. 298.

Family TEMNOPLEURIDÆ.

Genus TEMNECHINUS, *Forbes*, 1852.

Temnechinus Rousseaui, *d'Archiac & Haime*, sp.: p. 303.
—— affinis, *Duncan & Sladen*: p. 303.
—— stellulatus, *Duncan & Sladen*: p. 304.
—— Gajensis, *Duncan & Sladen*: p. 305.

Genus LEPIDOPLEURUS, *Duncan & Sladen*.

Lepidopleurus hemisphæricus, *Duncan & Sladen*: p. 306.
—— granulatus, *Duncan & Sladen*: p. 308.

Family TRIPLECHINIDÆ.

Genus HIPPONOË, *Gray*, 1840.

Hipponoë proavia, *Duncan & Sladen*: p. 310.
—— antiqua, *Duncan & Sladen*: p. 313.

Genus ECHINUS (*Rondel.*), *Linné*, 1758.

Echinus subcrenatus, *Duncan & Sladen*: p. 317.

Order **ECHINOIDEA EXOCYCLICA.**

Suborder GNATHOSTOMATA.

Family CLYPEASTRIDÆ.

Subfamily EUCLYPEASTRINÆ.

Genus CLYPEASTER, *Lamarck*, 1801.

Clypeaster profundus (*d'Archiac*), *Duncan & Sladen*: p. 319.
—— pulvinatus, *Duncan & Sladen*: p. 322.
—— pelviformis, *Duncan & Sladen*: p. 324.
—— complanatus, *Duncan & Sladen*: p. 325.
—— depressus, *Sowerby*: p. 327.

Family SCUTELLIDÆ.

Genus ECHINODISCUS, *Breyn., amended by A. Agassiz*, 1872.

Echinodiscus Desori, *Duncan & Sladen*: p. 328.
—— ——, var.: p. 328.
—— placenta, *Duncan & Sladen*: p. 329.
—— ellipticus, *Duncan & Sladen*: p. 330.
—— elongatus, *Duncan & Sladen*: p. 331.
—— sp.: p. 329.
—— sp.: p. 331.

Suborder ATELOSTOMATA.

Family CASSIDULIDÆ.

Subfamily ECHINOLAMPINÆ.

Genus ECHINOLAMPAS, *Gray*, 1825.

Echinolampas Jacquemonti, *d'Archiac & Haime*: p. 332.
—— spheroidalis?, *d'Archiac*: p. 338.

Family SPATANGIDÆ.

Subfamily SPATANGINÆ.

Genus SCHIZASTER, *Agassiz*, 1836.

Schizaster Granti, *Duncan & Sladen*: p. 339.
—— sufflatus, *Duncan & Sladen*: p. 339.

Genus MOIRA, *A. Agassiz*, 1872.

Moira, sp.?: p. 342.

Genus MEOMA, *Gray*, 1851.

Meoma, sp.?: p. 342.

Genus BREYNIA, *Desor*, 1847.

Breynia carinata, *d'Archiac*: p. 343.

Subfamily BRISSINA.

Genus BRISSUS, *Klein*, 1734.

Brissus, sp.: p. 354.

Summary of the Species of Fossil Echinoidea from the Gáj Series in Sind.

1. Cidaris opipara, *Duncan & Sladen*: p. 279.
2. —— excelsa, *Duncan & Sladen*: p. 282.
3. —— spp. (spines): p. 283.
4. Cœlopleurus Forbesi, *d'Archiac & Haime*: p. 287.
5. —— Sindensis, *Duncan & Sladen*: p. 298.
6. Temnechinus Rousseaui, *d'Archiac*, sp.: p. 303.
7. —— affinis, *Duncan & Sladen*: p. 303.

8. **Temnechinus stellulatus**, *Duncan & Sladen*: p. 304.
9. —— **Gajensis**, *Duncan & Sladen*: p. 305.
10. **Lepidopleurus hemisphæricus**, *Duncan & Sladen*: p. 306.
11. —— **granulatus**, *Duncan & Sladen*: p. 308.
12. **Hipponoë proavia**, *Duncan & Sladen*: p. 310.
13. —— **antiqua**, *Duncan & Sladen*: p. 313.
14. **Echinus subcrenatus**, *Duncan & Sladen*: p. 317.
15. **Clypeaster profundus** (*d'Archiac*), *Duncan & Sladen*: p. 319.
16. —— **pulvinatus**, *Duncan & Sladen*: p. 322.
17. —— **pelviformis**, *Duncan & Sladen*: p. 324.
18. —— **complanatus**, *Duncan & Sladen*: p. 325.
19. —— **depressus**, *Sowerby*: p. 327.
20. **Echinodiscus Desori**, *Duncan & Sladen*: p. 328.
21. —— ——, var.: p. 328.
22. —— **placenta**, *Duncan & Sladen*: p. 329.
23. —— **ellipticus**, *Duncan & Sladen*: p. 330.
24. —— **elongatus**, *Duncan & Sladen*: p. 331.
25. —— sp.: p. 329.
26. —— sp.: p. 331.
27. **Echinolampas Jacquemonti**, *d'Archiac & Haime*: p. 332.
28. —— **spheroidalis**?, *d'Archiac*: p. 338.
29. **Schizaster Granti**, *Duncan & Sladen*: p. 339.
30. —— **sufflatus**, *Duncan & Sladen*: p. 339.
31. **Moira**, sp.?: p. 342.
32. **Meoma**, sp.?: p. 342.
33. **Breynia carinata**, *d'Archiac*: p. 343.
34. **Brissus**, sp.: p. 354.

Total species described	27
Species not named	5
Varieties	1

Spines of several species unnamed.

III. *Description of the Fossil Echinoidea from the Gáj Series of Strata in Western Sind.*

Order ECHINOIDEA ENDOCYCLICA.

Family CIDARIDÆ.

Genus CIDARIS, *Klein*, 1734.

1. Cidaris opipara, *Duncan & Sladen*. Plate XLIV, Figs. 1–8.

Form circular, subdepressed, the height being less than two thirds the breadth. Unfortunately the large type specimen is somewhat crushed and these proportions cannot in consequence be given accurately; but a smaller example (in which the height would normally be greater) presents the above proportions exactly. When seen in profile, the inflation at the ambitus presents a very regular curve, full and well rounded, the contraction of the test being very little, if at all, greater actinally than abactinally.

Ambulacra considerably flexed, rather narrow, contracting towards the apex, and to a less degree towards the peristome. Poriferous zones rather shallow and not very deeply sunken, nearly as broad as the interporiferous area. Pores slightly oval transversely, those of a pair separated from one another by a space rather greater than their own transverse diameter, upon which is present a rather coarse and ill-defined elevation, limited to the aboral portion of the plate, the adoral margin of the plate having the appearance of being faintly channelled, but not definitely in connection with the pores, the feature being mainly produced by the thin elevated ridge developed on the aboral margin of the adjoining plate, by which the pairs of pores are separated. Near the apex the ill-defined elevation which separates the pores of a pair becomes more definitely granular. The two pores on a plate are similar in shape and size: and there are 16 or 17 pairs of pores opposite to one of the largest interambulacral plates at the ambitus. The interporiferous areas are of moderate breadth and are furnished with two rows of minute mammillated tubercles, placed at the extreme margins of the area, that is to say one on each plate adjacent to the inner row of pores. On the abactinal portion of the area the plates bear on the inner side of this small tubercle one still smaller miliary granule, in regular series; in the neighbourhood of the ambitus, however, the place of this granule is occupied by two miliary granules, standing one above the other, so that the regularity of the uniserial row of the inner miliary granules is unbroken.

The interambulacral areas are rather more than five times the width of the ambulacra at their widest part: and there are two rows of 7 to 8 primary tubercles in each interambulacrum, the tubercle, however, on the uppermost pair of plates being usually undeveloped. The primary tubercles are large, perforate, and non-crenulate, and their bosses are large and extensive, frequently somewhat tumid. The mamelons are broad and subdepressed, somewhat button-shaped, with the edge slightly bevelled or flattened in its rounding. The collar is wide and sensibly grooved, the neck is short and thick. The scrobicules are wide and extensive, circular on the abactinal surface, but becoming oval at the ambitus, and in an increasing degree towards the peristome. The scrobicular ring is complete, and composed of 15 to 16 conspicuous mammillated granules, or miliary tubercles, widely spaced. The mamelon of these granules is small, spherical, and well defined; the boss broad, subdepressed, and more or less expanded laterally, and often somewhat undulating in its surface. The scrobicular ring comes so close to the aboral and adoral margins, and the margin adjacent to the poriferous zone, that there is only room for single very minute miliaries here and there opposite the interspaces of the miliary granules of the ring. In the case of the margin adjacent to the poriferous zone the miliaries are rather larger and more frequent, but only a single row is present, except at the upper and lower corners of the plate, which are filled in with two or three additional ones. The miliary zone is very narrow, with a well-defined depression along the zigzag median suture; and more emphasized depressions occur at the places where the horizontal sutures of plates meet the median suture, in other words, at the corners of the plates. The miliary zone is occupied by a small, somewhat irregular, miliary granulation. The granules are irregular and generally diminish in size as they recede from the scrobicular ring, but are often irregular both in size and shape. Here and there some appear to have a tendency towards confluency, indicated rather by shape than by actual contact, and in some places on a few plates irregular and ill-defined channels may be traced from the scrobicular ring to the median suture; but no constancy can be noted in this character. Not more than three series of miliaries can be counted between the scrobicular ring and the median suture. The most aboral primary plate in each column of the interambulacral area has the primary tubercle imperfectly developed, and the region surrounding its scrobicule is well granulated.

The peristome is small and pentagonal, 16 millim. in diameter in a specimen 40 millim. in diameter at the ambitus. There is a rather strongly developed notch (still very minute) at the junction of the ambulacral and interambulacral areas (see Fig. 8, where the artist has perhaps rendered it a trifle too deep). Unfortunately the apical disk is wanting in all our specimens; but judging from the aperture presented by the type specimen (shown in Fig. 1) its size was relatively small for the genus.

Remarks. This species is distinguished from any other Indian form with which we are acquainted. It has some resemblances to the two Cidarids which we have described from Kattywar*, viz. *C. depressa* and *C. granulata*; but is distinguished from the former by the narrowness and character of the ambulacra, and from the latter by the same features, as well as the character of the ornamentation of the primary interradial plates. In *C. opipara* the narrowness of the ambulacral areas and the breadth of the interambulacral areas are remarkable, whilst the large size of the scrobicular areas, the prominence and isolation of the miliary tubercles of the scrobicular ring, and the diminutive size and paucity of the general miliary granulation of the interambulacral plates furnish well-marked characters.

Dimensions. The following are the measurements of four specimens :—

	a. millim.	*b.* millim.	*c.* millim.	*d.* millim.
Height . . .	30†	29·5	26·5	18†
Breadth . . .	53‡	43	39·5	31·5‡

Localities. In the Gáj series of strata :—

i. Four miles south-west of Beynír Hill. Survey-number G $\frac{302}{33}$.

ii. Scarp at Kúpo-jo-lak, or pass on the Mól range, west of Sháh-beg (same locality as G $\frac{280}{42}$). Survey-number G $\frac{302}{17}$.

iii. Naig-Nai valley, twelve miles south of Sháh Rhui. Survey-number G $\frac{302}{40}$.

iv. A few miles south of Pír Mangal (Mugger Peer). Survey-number G $\frac{302}{51}$.

v. Síta Nai, Khírthar range. Survey-number G $\frac{292}{3}$.

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[*] 'Tert. Echin. Kachh and Kattywar,' Pal. Ind. Ser. XIV. (1883).

[†] In these measurements the test is slightly crushed.

[‡] In the measurements thus marked, the test is slightly crushed out of shape, the measurement given being the mean of the major and minor diameters.

The specimens received from the two last-named localities are too much weathered for positive determination; they present, however, the chief characters of the species, and we feel little hesitation in referring them to it.

Illustrations of the Species in Plate XLIV.

Fig. 1. Abactinal view of the test: natural size.
2. Profile view of the same test: natural size.
3. Actinal view of a smaller specimen: natural size.
4. Ambulacral plates near the ambitus, from the same specimen as Fig. 1: magnified.
5. Ambulacral plates on the abactinal part of the area, from the same specimen: magnified.
6. Interambulacral plate, from the same specimen: magnified.
7. Portion of an ambulacral area, to show the flexure and the posture of the plates, from the same specimen as Fig. 3: magnified.
8. Portion of the margin of the peristome, from the same specimen: magnified.

2. Cidaris excelsa, *Duncan & Sladen*. Plate XLIV, Figs. 9–11.

There are two fragments of a *Cidaris* test, from different localities, in the collection of Gáj Echini, which, though unfortunately not well preserved, are still sufficiently marked to indicate that they belong to a species clearly distinct from any known Indian form, and also, we believe, from any hitherto described from other Tertiary areas.

In both cases the portion preserved consists of nearly the whole of an interambulacral area, and in one of the fragments half of the ambulacral area on either side is also intact. The following characters may be observed:—

Judging from the largest fragment, the test appears to have been high in relation to the breadth of the interambulacral area; and the tumidity at the ambitus was not great.

The ambulacra were slightly flexuous and decidedly broad. Poriferous zones only slightly sunken, and narrower than half the interporiferous area. Pores transversely oval, those of a pair equal and similar, placed near together and separated by a small elevation, forming an indistinct granule. There are 12 to 13 pairs of pores opposite one of the large interambulacral plates near the ambitus. The interporiferous areas are broad and ornamented with six longitudinal rows of comparatively widely spaced miliary granules. There are consequently three granules on each plate: that which stands adjacent to the poriferous zone is the largest, mammillated, and occupies nearly the whole of the depth of the plate. The two other granules are quite small and diminutive, little larger than the mamelon of the one just described, widely spaced, and standing near the adoral margin of the plate. The great breadth and apparent nakedness of the interporiferous area is remarkable.

The interambulacral areas are a little more than three times the width of the ambulacra (or, more exactly, the ambulacra may be estimated at three tenths the width of the interambulacra). The width of the interambulacral plates is remarkable, that of the large plates near the ambitus being proportional to their own length (*i. e.* height) as 1 : 0·55. In a similar-sized example of *C. opipara*, nobis, the plates occupying the same position have their width proportional to their length as 1 : 0·66. The primary tubercles are rather small, perforate, but not crenulate; mamelons moderately prominent, somewhat button-shaped, and with a well-incised neck. The scrobicules are transversely oval and extend close to the ad- and aboral margins of the plate. The scrobicular ring is complete, but the granules at the ad- and aboral margins are pushed so close to the edge of the plate as to appear to be slightly cut away. The space which intervenes between the scrobicular ring and the poriferous zone at the ambitus is a little more than half the space which intervenes between the scrobicular ring and the median suture, and is about equal to the width of half the interporiferous area. The scrobicular ring is composed of 22 to 24 small miliary tubercles, indistinctly mammillated and rather closely placed; the space on the poriferous side of the plate on the one hand and the miliary zone on the other being occupied by small miliary granules which diminish in size as they recede from the scrobicular ring, the granules or miliary tubercles composing the latter not being very much larger than the series of miliaries immediately external to them. This circumstance goes far to obliterate the prominence of the scrobicular ring, and imparts a characteristic facies to the form. The miliary granulation on the whole is well spaced; and indistinct traces of superficial channelling, forming lines of granules in single file, which pass from one scrobicule to the next adjacent, may be discerned here and there. The sutures of the plates are rather deeply incised, especially where the horizontal sutures fall into the median suture at the angles of the plates, and suggest more or less forcibly a Goniocidarid facies in this respect.

Dimensions. In the better-preserved fragment the width of the interambulacral area at the ambitus is 20 millim.; the length of the whole fragment 32 millim., which does not represent the full height of the test.

Localities. In the Gáj series of strata :—

i. Entering the hills on the road from Jangri to Búla Khán's Thána. Survey-number G $\frac{289}{35}$.

ii. Súmbak pass, east side; three or four miles north of the *darwat* or gorge of the Báran River. Survey-number G $\frac{280}{36}$.

Illustrations of the Species in Plate XLIV.

Fig. 9. A fragment of the test: natural size.
10. Ambulacral plates: magnified.
11. Interambulacral plate: magnified.

3. Cidaris, detached spines of several species. Plate XLV.

There are in the Gáj collection a large number of spines, probably belonging to several species of *Cidaris*. Of these it may be said that the majority have a striking

Phyllacanthid facies, in so far that they suggest the aspect of the spines of several of the existing forms referred to that subgenus. The variety of the form of the spines in the different living species of this subgenus, and the modifications both of shape and character on different parts of the same test throughout the whole genus are so considerable, that we consider it little more than frivolity and guess-work to assign specific names to the detached spines with which we have now to deal. This opinion is strengthened by the fact that we are quite unable to say which are the respective spines belonging to the two species of *Cidaris* described on the preceding pages; and it is not a little remarkable that whilst tests of *Cidaris* were found at seven different localities in the Gáj series, spines were found only at two of these (numbered by the Survey G $\frac{302}{33}$ and G $\frac{280}{28}$, at which localities the denuded tests of *C. opipara* and *C. excelsa* respectively were also obtained). Detached spines were met with at four other localities, but no fragments even of tests were found associated with them.

On Plate XLV we have given drawings of a representative series of the spines from the Gáj strata: they are faithful delineations of the fossils; and after the foregoing remarks the following brief notes on their characters and occurrences will probably be deemed sufficient:—

Figs. 1–12 represent a series of spines which recall in the most vivid manner the facies of spines of the type of the recent *Phyllacanthus verticillata*, Lamk. sp. The shaft is thick and massive, ornamented with a coarse, widely spaced granulation, annuli of larger and more prominent thorn-like granules being formed at intervals. These characteristic transverse ridges are, however, confined to one side of the shaft, the unarmed side, if it may be so termed, being occupied by regular longitudinal rows of uniform small granules (see Fig. 3 *a*, which is the unarmed side of the same spine as Fig. 3), often somewhat sharpened along their longitudinal axis and pointed outward; and the general surface of the spine between the granulation is occupied by very minute, uniform, microscopic granulation (see Fig. 12 *a*). Between the transverse ridges the granulation is widely spaced and more or less irregular, except towards the base (see Fig. 3 *b*). The basal articulatory portion of the shaft is small and contracts rapidly, and the margin is smooth and not crenulated. At the distal extremity the shaft is frequently flaring and cup-formed. Whether the spines represented by the series of Figs. 1–12 all belong to the one species it would, in our opinion, be hazardous to suggest. The spines of this type were procured at the following localities:— i. Entering the hills on the road from Jangri to Búla Khán's Thána. Survey-number G $\frac{280}{26}$. ii. Sarochi, three miles north of Pókhan (collected by Ram Sing). Survey-number G $\frac{302}{36}$.

Fig. 13 is a large massive cylindrical spine of the character of the recent *Phyllacanthus imperialis* and *P. dubia*; it is marked with fine longitudinal striations,—the edges of lamellæ; and the interspaces are filled in with a fine reticulated calcareous network. The fossil is more tapered at the extremity than the spines of the recent species we have mentioned, and the calcareous network between the lamellæ appears to be coarser. Furthermore the shaft does not expand as it approaches the collar, the whole region of the collar being somewhat contracted in our form and of less diameter than the shaft generally. Spines of this description, or fragments, were found at several localities, viz. :—i. Six miles east-north-east of Karáchi. Survey-number G $\frac{226}{18}$. ii. Entering the hills on the road from Jangri to Búla Khán's Thána. Survey-number G $\frac{280}{28}$. iii. Sarochi, three miles north of Pókhan. Survey-number G $\frac{302}{36}$. iv. Base of scarp four miles west of Trak Hill. Survey-number G $\frac{302}{33}$.

Figs. 14 and 15 are two *Cidaris*-spines of a rather elongate form, which tapers to a fine extremity, and shows considerable variation in the prominence and coarseness of the thorn-like granules of the ornamentation. A large number of examples of this type were found at a locality four miles south-west of Beynír Hill. Survey-number G $\frac{302}{23}$.

Fig. 16 is a comparatively delicate cylindrical spine, and the fragments we have studied indicate no trace either of inflation or tapering, in this respect recalling most nearly perhaps the habit of the recent *C. papillata*; the granulation, however, is small and definitely granular, and disposed in regular longitudinal lines. Fig. 16*a* represents a portion magnified. There seems little doubt that this form of spine belongs to a species distinct from any of those hitherto noted. The collection contains only a few fragments which came from the base of a scarp four miles west of Trak Hill. Survey-number G $\frac{302}{33}$.

Fig. 17 is a spine of *Cidaris* about which we have some doubt. It resembles the fossil given in Fig. 16 rather closely in the style of ornamentation (see Fig. 17*a*), but differs both in the collar and in the inflated and subfusiform shaft, and appears to present nearer alliances to the series to which Fig. 20 belongs. It seems also to differ too widely both in general habit and character of ornamentation from the spines represented by Figs. 14 and 15 to be ranked as belonging to the same species, notwithstanding the fact that it was found in the same locality, four miles south-west of Beynír Hill. Survey-number G $\frac{302}{23}$.

Fig. 18 is a small slightly flattened spine which does not belong to *Cidaris* at all. It is the only example obtained, and comes from Sarochi, three miles north of Pókan. Survey-number G $\frac{302}{36}$.

Figs. 19–28, with the exception of Fig. 24, represent a series of spines selected from a large number, which we believe to belong to one and the same type, notwithstanding a great amount of variability in the inflation of the shaft and in the manner in which the spinulate ornamentation is developed. It is easy to pick out extreme forms in this series which at first sight appear irreconcilable to such a view; but on careful study of the material, intermediate forms may be found which more or less clearly unite the extremes and seem to justify the assumption that all belong to the same species. Species of recent *Cidaris* may be pointed to in which the variability of the spine is quite as great. The spines, which were inferentially referred by d'Archiac and Haime to their *Cidaris halaensis* (An. foss. de l'Inde, p. 197, pl. xiii, figs. 3*a*–*f*), are unquestionably represented in this series, and Figs. 21, 22, 23, and 28 may be taken as typical examples of that form; but we can offer no support or confirmation to the suggestion of our learned predecessors—indeed, the evidence seems rather to oppose the correctness of that view. In the Miocene series of Kachh we have already noticed fragments of a test which we refer to *C. halaensis*, d'Archiac and

Haime, and a number of detached spines were also met with in the same measures. None of these, however, find a counterpart in the Gáj collection—evidence, though negative, which goes strongly against the assumption that these spines belong to *C. halaensis*. Throughout the series the shaft is more or less inflated in the region of the lower third, producing a subfusiform profile; and the distal extremity appears to have often been flaring and cup-shaped. The ornamentation is more or less spinulate, and is nearly always larger and more strongly developed on one side of the shaft than the other. Figs. 22 and 22*a* represent opposite sides of the same spine; Fig. 22*b* a portion magnified. In some cases the spinulate ornamentation appears to have been almost monstrously developed, as in Fig. 19, and it would be hard to say, with any degree of certainty, that this spine was properly placed in this series. It is also doubtful whether Figs. 26 and 27 really belong to the same species as the rest of the series; in both, the inflation of the shaft is very slight, and in Fig. 26 the spinulate ornamentation is smaller and more numerous than in any of the others. In Fig. 27 the ornamentation is disposed in longitudinal lines, and the thornlets composing it are very erratic and irregular in their development.

Fig. 24 does not belong to the so-called *C. halaensis* type. It is a fragment of what was probably a straight cylindrical spine, with widely-flaring cup-formed extremity (and figured on that account); its ornamentation is comparatively small, rather widely spaced, and in longitudinal lines. The spines represented in Figs. 19–28 were all found at the base of a scarp four miles west of Trak Hill. Survey-number G $\frac{302}{32}$. Others, similar to some of them, at Sarochi, three miles north of Pókhan. Survey-number G $\frac{302}{36}$.

There is a small much broken fragment of a more echinulate spine than any of those above noticed, which recalls the character of two of the spines we have previously figured from the Miocene of Kachh (Tert. Echin. Kachh and Kattywar [*], pl. viii, figs. 11 and 14). In this example the ornamentation is sharply echinulate, confined entirely to one side, and does not show any tendency to form transverse ridges. It was found six miles east-north-east of Karáchi. Survey-number G $\frac{226}{18}$.

Family ARBACIADÆ, Gray, 1855.

Genus CŒLOPLEURUS, *Agassiz*, 1840, amended.

The occurrence of species of the genus *Cœlopleurus* in the Tertiary deposits of Sind was noticed by d'Archiac and Haime in their great work, and they described three species. Of these, one had already been described by Klein, and renamed by Agassiz *Cœlopleurus equis*, and the others were new to science. The distinguished authors of 'Les Animaux fossiles de l'Inde' considered that all their species of the genus *Cœlopleurus* came from the Nummulitic strata, but we find that only two of them came from that horizon. One is a Miocene form, not only in Sind, but also in

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[*] Pal. Indica, Ser. XIV. (1883).

Kachh and Kattywar. The second Nummulitic species is *Cœlopleurus Pratti*, d'Archiac and Haime, and the Miocene form is *C. Forbesi*, d'Archiac and Haime.

We have noticed that the true horizon of the *Cœlopleuri* in Sind is not so low as the true Nummulitic limestone; but it is that of the Oligocene strata of the Nari series, which contain a few species of Nummulites. No species has been found in the Khirthar series or in the Ranikot beds, the first named containing the true Nummulitic limestone.

Our descriptions of *C. equis* and *C. Pratti* will be found on referring to the Fasciculus on the Nari Series or Oligocene of Sind *.

In describing the *Cœlopleuri* of Kachh we redescribed *C. Forbesi* (page 53), and we noticed that, as this species occurred in Kattywar, we should consider its details more carefully in dealing with the fossils from that locality. But on investigating the forms from that Miocene horizon, we found that there were points about them which required much more study, and a probable alteration of the generic diagnosis. Hence we did not give any further information, and we trust that this explanation will be sufficient.

The specimens of the genus *Cœlopleurus* in the Miocene strata of the Gáj group are numerous, and some are in a very fair condition of preservation. The forms vary much in the different stages of growth, and yet those which, on a superficial view, would be called *C. Forbesi*, d'Archiac and Haime, can be readily separated from the others. They are larger and more tumid forms.

Yet there is no doubt that if the specific diagnosis of *C. Forbesi*, as given in 'Les Animaux fossiles de l'Inde,' be depended upon, the forms cannot come under that species. MM. d'Archiac and Haime were furnished with most wretched specimens, in fact, with such as no modern palæontologist would care to describe. Hence their diagnosis is correct where they clearly saw details, and just as incorrect where they had to assume. Whilst we retain the specific name of *C. Forbesi*, and still associate it with the names of the distinguished French palæontologists, it must be understood that very few of their special characters remain and that the specific diagnosis is almost entirely new.

Our discovery of the nature of the ambulacral plates in relation to the tubercles, and the development of the tubercles of the ambulacra, affects the old diagnosis considerably. So does the presence of the perforations at the angles of the sutures of the ambulacral median line, noticed in the recent forms by A. Agassiz, and the presence of a tag on either side of the ambulacra, at the peristome.

1. CŒLOPLEURUS FORBESI, *d'Archiac & J. Haime*, amended. Plate XLVI, Figs. 1, 2, 4, 7, 9.

The test is large and tumid, and rather high; above the ambitus the slope is but slight to the apical disk, and this slope commences where the diameter of the test is greatest. From this part there is a gradual narrowing down to the surface upon which the test rests. Actinally the test is very slightly convex and tends to be flat, and the comparatively small peristome is in the midst of a decided concavity, or, in other words, the edge of the peristome is at a higher level than the surface just mentioned. The breadth of the test greatly exceeds the height, and the contour from above is nearly circular, an apparent angularity being sometimes given by the projecting tubercles of the ambulacra. From below the aspect is circular at the narrowing part.

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* Pal. Indica, Ser. XIV. (1883), Tert. Echin. of Kachh and Kattywar.

The apical system is on the top of the low slope upwards, from the widest part of the test; it projects with a different slope from that of the test below, and is well developed. The periproct is large, somewhat elliptical, its long diameter being between interradium no. 3 and ambulacrum no. 1. The basals are large and form the anal ring; they are slightly raised into a marginal ring which is ornamented with a continuous row of close granules, and they are perforated for the ovarial duct, either at mid-distance between the periproct and their adoral angle, or in the outer third of their length. The pore is large and may or may not have a raised rim. The adoral angle of a basal extends well into the interradium, and only slightly more adorally than the radial plates close by.

The greatest breadth of a basal plate is at a little distance from the anal edge, and all the sides are slightly and symmetrically concave, and the three angles on either side of the plate are distinct and moderately open. The madreporite is in the largest plate. The radial plates are large, broad as a rule, broader than high, and the sides, which are in contact with the basals, are slightly outward curving, whilst the adoral sides are slightly concave. The adoral edge is concave, and has a centrally downward projecting and more or less sharp granule, which is continued on to the upper surface of the plate as a part of the ornamentation, and also downwards and inwards so as to separate the optic tract into two parts. Hence there is no pore on the surface of the radial plate, but there are two, one on each side of the inwardly projecting process at its adoral edge, and they are more or less hidden. The outer angles of the radial plates correspond with the position of the second pair of ambulacral pores. In some radial plates there is a double curve at the adoral edge, and then the process occupies the intermediate projection. The radial plates never enter the anal ring.

The apical plates are thick and closely sutured, and it may be noticed in some specimens that there is a furrow over each suture which is crossed or not by the ridges and furrows of the ornamentation. The ornamentation of the apical system is of large granules, some solitary and bluntly conical, others in series, and most more or less united to form ridges with intermediate furrows. The ornamentation radiates laterally from a greater or less tubercle of the third order, which is on each basal plate between the genital pore and the granular rim of the plate. There is often a little group of granules at this spot and it forms a centre of radiation. Several ridges and intermediate grooves pass outwards and slightly adorally, cross the basal plate to its outer edge, and become continuous with a series of ridges and grooves which are upon the contiguous radial plate. Usually there is little or no ornamentation on the basals adorally to the pore; but there are exceptions to this, and there may be a row of small miliaries close to the edges of the plate. The ornamentation of a fully developed basal plate consists of the row of nearly separate granules close to the anal edge, a few small granules a little adorally to these, a tubercle of the third order, and lines of ridges and grooves passing from these outwards and slightly downwards, to cross the sutures of the radial plates on either side. Then comes the pore, with or without a raised rim, and there may be granules adorally to the pore.

The ornamentation of the radial plates is mainly continuous with that of the basals on either side. On a fully developed radial there is a central discontinuous ridge, broken up here and there into elongate and conical granules, ending adorally in the projection already noticed as having a relation to the optic pores. On either side of this vertical ridge and granule-tract are two or even three ridges and grooves, placed obliquely, and corresponding with the basal structures. Usually a ridge is near the side of the radial plate, and it may have no relation to a basal one.

The ambulacra are well developed, are tumid, and project more than the interradia above the ambitus, have a few small primary tubercles abactinally reaching up to the radial plate, and carry very large primaries at the ambitus and just below. Petaloid above, the ambulacra are rather broad at the peristome, and nearly as much so as the interradia; moreover, the peristomial margin has a rather deep concavity between the last pair of tubercles; and there are slight cuts on either side of the ambulacra, which are deeper than the concavity just mentioned, and a part of a cut and of the tag that passes up from it, externally to the pores, belongs to an ambulacrum.

On the abactinal surface, at the level of the third and of the fourth interradial plate, the ambulacra are slightly narrower than the interradia; at the ambitus the difference is less, especially in full-grown specimens.

The poriferous zones are broad and nearly straight down to the first large tubercle, and then they become exceedingly irregular and form a series of arcs with the concavity towards the tubercles; but near the peristome there is a disposition to form oblique series. There are no extra plates near the peristome, and throughout the zones there is an arrangement in triplets, except close to the radial plate.

The plates of the ambulacra, in their poriferous parts, are large and broad; they are of nearly equal height near the radial end, and increase in height to the ambitus. There is a still greater increase in height in the plates of the triplets of the great tubercles, and a gradual diminution of those below the last great tubercle down to the peristome, where the plates are very low.

The pairs of pores are large after the second pair; they are wide apart vertically, and there is an obliquity in their direction, even very high up in the ambulacrum, and this becomes decided at the ambitus. The pores are usually large and wide apart; but they are smaller and closer near the peristome, where the aboral pore of each pair is placed much higher in the plate and only a little to the outside of the adoral pore, which occupies the usual position at the lower suture of each plate. There is a rapid diminution in the size of the plates and of the size of the pores near the peristome; but the plates are broad there, extend into the tag, and the pores are remote from the outer or interradial suture.

The interporiferous area is narrow near the apex, increases gradually to the part of the tumid circumference where the diameter of the test is the greatest, and then gradually diminishes, but not to a point; for, as has been noticed, there is a rather broad peristomial termination.

The area is crowded with great tubercles, which begin just above the ambitus and reach below it. Above there are a few smaller yet well-developed tubercles, and actinally they diminish to the peristome, where the crowding is greater than it is above. Still smaller primary tubercles occur at regular intervals close up to the radial end, and the first great primary, smaller, however, than the next in succession towards the ambitus, is clearly higher up on the test than the highest great tubercle of the interradia.

In full-grown individuals there are at least eighteen fully-developed tubercles, and about four or five which are small and imperfect in their arrangement of the triplets. Eight of the perfect tubercles are very large and the rest decrease in size to the peristome, but they are unlike the apically situated small tubercles in shape and pore arrangement. In all the mamelon is small, has a constricted neck surrounded by a shallow groove, and a large conical inward and upward sloping boss, which has a wide flat base, which may extend quite to the edge of the plate, or leave a narrow space there at the median line of the zone for a single row of small granules. This row of granules may extend on to the line of suture between the successive plates on either side of the median line.

The perfect primary tubercles consist, as is usual in the genus, of a large primary plate which carries the mamelon and the greater part of the boss and all of it near the median line of the area; and of two demi-plates, one placed abactinally, and the other actinally in relation to the central primary of the compound plate.

These demi-plates form the aboral and the adoral flanks of the boss of the tubercle, but do not enter into the composition of the mamelon. Neither do the sutures of these demi-plates come in contact in any way. As is usual in the genus, the suture or edge of the aboral demi-plate, which is indented by the inner pore of the pair, passes inwards up the side of the boss to reach the groove at the abactinal edge of the neck of the mamelon, and it then passes either directly abactinally, or abactinally and slightly externally (Plate XXXIX, Fig. 12, Nari Series). In the first case the suture will end by joining the adoral sutural line of the plate immediately higher in the test, and in the other the suture will pass so as to reach the adoral pore of the higher plate. The adoral demi-plate is of the same shape as the other demi-plate. Its aboral suture is of course in contact with the adoral edge of the poriferous part of the central or primary plate of the triplet, and after being in relation with the adoral pore of the primary, its line of suture passes up the boss to the groove at the edge of the neck of the mamelon and then turns either directly actinally, or actinally and slightly externally, so as to reach the line of suture between the consecutive great tubercle-bearing plates, or to reach its own adoral pore.

The shape of the central plate of the triple combination is very remarkable. The poriferous part, situated between the poriferous parts of the demi-plates above and below, extends from the interradial edge inwards and includes the space as far as the edge of the tubercle. The rest of the plate comprises the portion of the tubercle bounded above and below by the sutures of the demi-plates, and further, towards the median line of the ambulacrum, it forms the whole of the rest of the tubercle and the granular edges.

The size of the poriferous part varies according to the position of the edge of the tubercle, and frequently the adoral pore comes in contact with and even indents it. Then the size of the poriferous part is small. The other part occupies the inner half of the compound plate, and therefore the greater part of the tubercle, all the mamelon, and the greater part of the groove around it. A line drawn vertically, over the top of the mamelon and reaching from the aboral to the adoral suture of one of these tubercle-bearing plates, will nearly bound the inner expansion of the central or primary plate, all between the line and the inner sutures of the plate belonging to it. So that the large central primary plate of the triple combination, or compound plate, consists of a narrow outer part placed between the demi-plates, and of a large inner expansion which extends over the inner half and more of the great tubercle.

Near the peristome, where the height of the triple combinations diminishes, the aboral and the adoral demi-plates are more rectangular in shape, and the inner line of suture of both of them is nearly vertical in its direction. In this region the central or primary plate of each combination is small, although it bears the bulk of the boss and all the mamelon. Whilst in all parts of the ambulacrum remote from the peristome, the plates are perforated by the aboral pore of the pair close to their outer or interradial edge, near the peristome the perforation is remote and nearer the median line, the outer edge of the plate forming a part of the "tag."

There is some slight obliquity of the direction of the pores of each pair in relation to the first large tubercle-bearing plate, and the aboral pores are at a slightly higher (abactinal) level than the adoral. This obliquity is more distinct at the second tubercle, and its lower pair of pores are often decidedly on a slant, the aboral pore being higher up the test than the adoral.

The obliquity increases in every pair of pores towards the peristome, and close to the margin the aboral pore is nearly vertical to the other, but a little on one side of the vertical line.

There is some variation in the amount of the obliquity of the pores near the peristome, but it is always decided. Moreover there is an interesting alteration in the relative position of these peristomial pores, for instead of being close to the base of the tubercle, as in the large tubercles, they are decidedly removed from it, and the adoral pore does not touch the tubercle.

Again, the aboral pores of the large tubercular plates are close to the edge of the poriferous plate, but as the tubercles diminish in size towards the peristome, the aboral pore gets further away from the interradial edge, so that there is some extent of plate between it and the edge.

This closing in of the pores upon a contracting tubercle is accompanied by an alteration in the shape of the demi-plates of each triple combination. The demi-plate above, and also that below the tubercle-bearing one, become nearly rectangular in shape, the angle of the sutures (inner) is nearly or quite a right angle, the direction of the inner sutures is nearly vertical, and the upper and lower margins of the demi-plates are nearly horizontal, instead of converging more or less. The plates become small as they approach the margin of the peristome, are slightly inverted, and the last is a small demi-plate the adoral pore of which is incomplete and opens at the peristome.

The outer part of the smaller poriferous plates near the peristome extends sufficiently to form part of the surface of the prolongation of the small branchial cut which may be termed a "tag." The termination of the ambulacra at the peristome is slightly incurved and reaches slightly nearer the centre of the actinal space than the ends of the interradia, which are straight and narrow. There is a concave edge to the interporiferous area at the peristome, and immediately a little transverse projection of the test is passed, towards the ambitus, there appears a large central pit, and it is evidently on the median suture between two tubercle-bearing plates. In well-preserved specimens of *C. Forbesi* the pit is as large as the mamelon of the tubercles close by, and whilst the base of the pit, or rather its actinal edge, is transverse and straight, the upper or aboral edge is arched. There are usually five similar pits in each ambulacrum and they are large, shallow, arched when well preserved, and they are placed at the junctions of the median with the lateral suture.

The arrangement of the plates of the ambulacra is readily perceived at the ambitus, but it becomes complicated near the radial end, where there is considerable variation in the succession of small primaries, demi-plates, low primaries, and an occasional large primary. The arrangement of the plates, in this part, foreshadows and finally merges into the triple compound arrangement seen at the ambitus.

In a well-preserved specimen of nearly adult size, the following succession of plates will be found in ambulacrum III.:—

Taking zone "*a*" and noticing the nature of the plates from the radial plate actinally, it is found (Fig. 7, Pl. XLVI) that there is the following succession:

Plates 1, 2, 3, 4 are small low primaries gradually increasing in size. Plate 4, a primary, is pushed as it were aborally by the aboral expansion of plate 7, and just escapes being a demi-plate, for it only touches the median line by a narrow point. Plate 6 is a demi-plate, separated from the median line by the large tubercle-bearing primary plate 7, and it forms the shoulder of the tubercle and is very small. Plate 7, a tubercle-bearing primary. Plate 8 is a low primary, and so is plate 9. Plate 10 is a primary which, were there a greater expansion of the tubercle-bearing plate 12, would, like its successor 11, become a demi-plate. Plate 11 is a small demi, forming the aboral demi-plate of a triple combination plate made up of plates 11, 12, and 13. Plate 12 is the tubercle-bearing primary, and 13 is a large demi-plate. After this there comes the normal compound plate of the ambitus.

In zone "*b*" the three plates nearest the radial plate are small primaries; the plate 4 is crowded out from the median line by the abactinal expansion of a small tubercle-bearing primary 5, and thus plate 4 becomes a demi-plate and is combined with plate 5. Plate 6 is a primary with a small angular interporiferous part in consequence of the downward extension of plate 5 occupying much space. This angular primary is almost a demi-plate. Plate 7 is a low primary with granules. Plate 8 is a primary with an angular interporiferous part: for the expansion of plate 10 extends abactinally so as to crowd out almost the whole of plate 8 and the whole of plate 9, which is a demi-plate. Plate 10 is a large tubercle-bearing plate with an abactinal and actinal expansion. The demi-plate 9 forms the shoulder of the tubercle of plate 10. More abactinally there is a low primary, and then the normal succession occurs at the ambitus of the demi and primary plates in triplet combination.

As in all species of *Cœlopleurus* the edges of the large tubercles, at and below the ambitus, are indented by the adoral pore of each pair, and the line of the sutures on the boss of the tubercles is indicated either by a depression or by a slit.

Finally in very well-preserved specimens, the poriferous part of the plates has a very well-developed arched ridge-like costa situate between the pairs, and it may carry a granule and terminate in one.

The succession of primary and demi-plates noticed in the last pages, although affording a good example, is not invariable. The following analyses of several ambulacral areas is given with the intention of showing that although the succession of the plates near where there are large tubercles is arranged and combined in a geometrical plate—a demi-plate, a large primary with the mamelon, and lastly a demi-plate—still this arrangement is not seen near the top of the ambulacrum. It commences, however, in every ambulacrum not very far down, but the distance relates to the age of the test and in the apparently introductory manner suggested in the long description already given. In that description the small higher and last formed plates were not considered, but they enter into the following descriptions.

Ambulacra of a rather large specimen of *Cœlopleurus Forbesi*, d'Archiac, the amb. No. III. being examined:—

Zone "*a*," pl. 1, 2, 3, 4, $\overbrace{5d,\ 6,}$ 7, $\overbrace{8,\ 9d,}$ $\overbrace{10d,\ 11}$, 12.

Zone "*b*," pl. 1, 2, 3, 4, 5, 6, 7, $\overbrace{8d,\ \mathrm{ix},}$ 10, 11, 12*d*, $\overbrace{13d,\ \mathrm{xiv},\ 15d,}$ $\overbrace{16d,\ \mathrm{xvii},\ 18d}$.

The plates marked "*d*" are demi-plates, and the others are primary plates; those with roman numerals are large tubercle-bearing plates. It will be observed that the first plates are all primaries; they are small, but each reaches the median line of the ambulacrum.

The first little tubercle-bearing plate is 4 on zone "*b*," and it has small primary plates above and below. The next is on the zone "*a*" on plate 6; but this tubercle is larger than that of the higher plate "*b*" 4, and the result is that the preceding plate on zone "*a*," or no. 5, is a demi-plate.

The third tubercle-bearing plate is on zone "*b*" no. ix, and it is the first of rather conspicuous dimensions. The fourth tubercle-bearing plate is xi of zone "*a*," and it is fairly large. It is preceded by a demi-plate no. 10; but the next plate is not a demi, so that the perfect triple combination does not occur so high up. The fifth large tubercle-bearing plate is really of considerable size and is no. xiv on zone "*b*," and it is preceded and followed by a demi-plate, so that the triple combination is complete.

In another specimen the following is the order of the succession of the plates:—

Zone "*a*," 1, 2, 3, 4*d*, 5, 6, 7, 8*d*, 9, $\overbrace{\text{x}, 11d}$.

Zone "*b*," 1, 2, 3, 4, 5, 6, 7*d*, 8, 9, 10, 11*d*, $\overbrace{12d, \text{xiii}, 14d}$.

The last-noticed three plates of zone "*b*" form the first triple combination.

Small tubercles are on "*a*," 5 and on "*b*," 8 and 10.

The interradia are very slightly broader than the ambulacra, and are depressed and even slightly caved in above the ambitus, but at the ambitus and below to the peristomial margin there is hardly any difference between the circumferential dimensions of the two areas. The plates are high except at the peristome, and are nearly square, or rather are nearly as broad as high when they carry the largest tubercles; but all the plates are remarkable for the obliquity of the direction of their aboral and adoral sutures near the poriferous zones of the neighbouring ambulacra. Near the peristome the whole plate is oblique and slants down from the median line of the interradium. This general obliquity is in relation, above the ambitus, with the obliquity of the pores, and it also relates to the special ornamentation of the outer part of every coronal plate above the ambitus, and to the position of the characteristic row of well-developed secondaries lower down.

The outer part of each coronal plate, for about one third of its breadth, is ornamented with small secondaries, large and small rounded granules, and with irregular-shaped narrow ridges and furrows.

The second large plate from the apex has a small secondary on the oblique part close to the adoral outer angle; plates 3 and 4 have each two of these tubercles and in the same relative position.

Plate 5 has three small secondaries on its extremely oblique adoral and outer part, and the next plate has four. There may be a repetition of the four tubercles on the plate below, and they slope round the flank of the tubercle more or less vertically at last, and this appearance is intensified by the occurrence of a secondary on the outer and upper part of the plate below. Near the peristome the number of these side tubercles diminishes from three to two, and then, before the plates become very small, to one.

These details are usually very constant, and in full-grown specimens the rows of small secondaries close to the large tubercles are very striking.

There is great diversity in the arrangement of the granules and ridges, however. There are often rows of large granules placed between the small primaries, and intervening are rows of small granules. The direction of the rows is often the same as that of the oblique secondaries; but the granules are placed higher up the plates than the secondaries. In those upper plates which have not tubercles there is usually a bunch of close granules halfway up the outer third, and elegant ridges and furrows radiate from the group and pass over the breadth of the plate to the median line, and then on to the opposite plate, ornamenting the adoral or the aboral part of its surface as the case may be. A zigzag arrangement is thus produced, and the ridges and furrows are long and very variable in size. Usually the outer third of the plates above the ambitus is slightly raised above the general level of the interradium, and there is often a raised discontinuous ridge bounding the outer part of each plate up to the apex. This ridge often has a furrow on the median side of it. The granules and the small secondaries are comprehended in a slightly raised surface near the poriferous zones and external to the zigzag ornamentation of the rest of the plates.

Large tubercles commence on the eighth plate from the apex as a rule; but there is variation on the same test in this respect. There are usually six decidedly large primaries, and the tubercles become gradually smaller and smaller to where they are crowded above the peristome.

The coronal plates just above, at, and below the ambitus, are not only well furnished with distinct and large granules around the edge of the base of the tubercles, especially aborally, adorally, and along the median sutural lines, but there are also small and well-developed secondaries in the median line, and especially at the junction of the other sutures with it. Above the first large tubercles there is, in well-preserved specimens, a very considerable granulation. The shape and size of the primary tubercles is the same as in the ambulacra.

It is evident that this species can be distinguished by the granulations and small secondaries of the median part of the interradia, by the numerous small secondaries on the oblique part of the coronal plates, by the almost total absence of tubercles above the zone of greatest width, by the continuance of small tubercles to the top of the ambulacra, and by the tumid and large test.

Dimensions. Height of large specimen 21 millim.; breadth 38 millim.

Localities. Gáj or Miocene of Sind: Pir Gáji, W. of Sehwan; Tandra Ráhim Khan, W. of Sehwan; Gandack Hill; hill-scarp five miles N. of Sháh Rhúi, on the Naig Nai, S.W. of Jangára, Naig Nai valley; Mendiári, 35 miles N. of Karáchi. Survey-numbers G $\frac{226}{48}$, G $\frac{226}{49}$, G $\frac{302}{45}$, G $\frac{302}{41}$, G $\frac{302}{40}$, G $\frac{302}{46}$, &c.

Illustrations of the Species in Plate XLVI.

Fig. 1. The test, side view.
2. A test more tumid than the other.
7. The aboral part of an ambulacrum: magnified.
9. Peristomial part of ambulacrum: magnified.

The drawings of the great tubercles of *Cœlopleurus Pratti*, d'Archiac, on Plate XXXIX, Figs. 7 and 12 (Nari Series), are also exact representations of the worn and weathered specimens of *Cœlopleurus Forbesi*, d'Archiac.

COELOPLEURUS FORBESI, *d'Archiac & Haime.* Premature form.

A young form (Plate XLVI, Fig. 4) is 11·5 millim. in breadth and 6 millim. in height. The test is tumid at the ambitus, slightly conical above, rather pentagonal in outline when seen from above, and rather incurved actinally, where the peristome is moderately large.

The ambulacra project more than the interradia, the primary tubercles of which are the smallest at the ambitus. The median interradial areas, above the ambitus, are sunken below the level of a raised line or ridge, composed of a linear series of small secondaries and granules which occupies nearly the outer third of each coronal plate. The plates of this part of the test are higher than broad, and are indistinctly ornamented with a small secondary tubercle, or there may be two or more of such tubercles, forming a linear series. Sometimes a small pit is seen in the position of a tubercle. The sutural lines between the tubercle-bearing plates are very distinct, slightly excavated, and there is a remarkable denticular interlocking of the edges of the opposed plates. The direction of the upper interradial plates is transverse. Including the small new plates in contact with the basal plates, the first primary tubercles are on the fifth interradial plates from the disk. One of these tubercles is larger than the other, and both are of the usual shape of the tubercles of the genus. The plates are, however, not with sutures that are uniformly transverse in direction, for their outer and adoral angle is directed slightly adorally, towards the poriferous zone, close by; moreover this part of the plate carries at least two small secondaries.

There are a few granules upon the aboral edges of these plates. The dimensions of the primary plates diminish rapidly towards the peristome, and they become crowded there and the interradium becomes narrower. There are at least four large tubercles, and the couple next to the highest are the largest, namely those of the sixth interradial plates.

The ambulacra are well developed, and the size of the tubercles at and above the ambitus is considerable. The pairs of pores are in arcs at the edges of the great tubercles, and the sutures are in the same direction as in the adult specimens. But the number of small plates in the interporiferous area towards the radial end is small, and the development of the triplets occurs high up. The pairs of pores are large and by no means close, there being two pairs in relation to the first interradial plate and three to the second; moreover the direction of the pores is decidedly oblique, and from the interporiferous area outwards and upwards. In each poriferous plate there is a broad rather high process, which separates the pores from the aboral edge, or the line of suture that limits the plate from that immediately above. There is a gradual increase in size of the pairs until the seventh, when the triplet arrangement becomes evident, the pairs wider apart, and the pores larger. The following is the disposition of the plates in one of the ambulacra:—

No. III. Zone "*a*"—Plate 1, small primary.	Zone "*b*"—1, small primary.
2, small primary.	2, small ,,
3, small demi.	3, small ,,
4, large primary.	4, small ,,
5, small demi.	5, small ,,
6, small demi.	6, large ,,
7, large primary.	7, small demi.
8, small demi.	8, small demi.

No. III. Zone "*a*"—Plate 9, small demi.
10, large primary.
11, small demi.

Zone "*b*"—9, large primary.
10, small demi.

In the zone "*a*" the tubercle-bearing plates are Nos. 4 and 7, whilst those of the other zone are Nos. 6 and 9. After the triplets on zone "*a*" formed by Nos. 6, 7, 8, comes a very large tubercle-bearing plate composed of plates 9 a demi, 10 a very large plate, and 11 a demi.

In the zone "*b*" the tubercle-bearing plates are Nos. 6 and 9 and the triplets are Nos. 5, 6, 7, and 8, 9, 10. The sutures between the great tubercle-bearing plates of the ambulacra are very distinct, in sunken grooves. At the median line, where the sutures intersect, there is sometimes a pit even close to the ambitus. Nearer the actinostome the usual development of the large pit at each angle of the plates along the median line is seen, and there is no doubt that the shape of the pit is that of a broad archway with a flat floor. The pits are large for the size of the test. Two are close together just at the edge of the peristome; these are the largest, and they are so well preserved that the little process for the sphæridium is visible. In parts the denticulate sutural edge of the ambulacral plates is quite visible under a low power. The pairs of pores are in simple triplets to the peristome and there are no additional pores in the arcs.

The apical ring is well developed, and the orifice is subcircular and large, and the whole of the combination of plates is somewhat raised beyond the rest of the test. The basal plates are large and subequal, with the outer angle rather blunt and projecting well into the interradial area. The ovarial pores are large, and placed at about the outer third, and there appear to be the remains of a small tubercle between each one and the periproct. The radial plates are large, well separated from the periproct by the junction of the basals, and the adoral edge is concave and has the relics of a small central downward-projecting process. There is no perforation for the optic nerve, and this evidently came out beneath and below the concave adoral margin, and was separated into two by the process just noticed. Unfortunately the ornamentation of the radials has been worn off; but this erosion has exposed the interesting denticulate dovetailing of the plates at their lines of sutures. The denticulation is visible between the basals and the radials and also between these and the first plates of the interradia.

This small specimen came from the Gáj group; but the locality is not stated.

Illustrations of the Form on Plate XLVI.

Fig. 4. The test: natural size.

Numerous specimens of a *Cœlopleurus* which, although clearly allied to *Cœlopleurus Forbesi*, are not of the same species, are found in the Gáj deposits. The specimens did not come from the same localities as *Cœlopleurus Forbesi*, but we are not informed about there being any difference in the geological horizons of the two sets of forms.

2. **Cœlopleurus Sindensis**, *Duncan & Sladen.* Plate XLVI, Figs. 3, 5, 6, 8, & 10, and Plate XLVII, Figs. 1 & 2.

The full-grown test is large, depressed, moderately tumid, and not high at the ambitus, and decidedly conical towards the apex. The peristome is small and at a higher level than the resting part of the test, the cuts are small but distinct, and the under surface is rather flat. The apical disk is large and rather prominent, and the large periproct is oblique. The basal plates are large, with a large circular or elongate pore with or without a raised rim. The radials are also large and imperforate, there being a median projection on the surface besides the ridges and furrows seen in other species.

The ambulacra are slightly raised above the level of the interradia, above the ambitus, and are characterized by the large and somewhat irregular granulation of the interporiferous areas, and by the absence of secondary and small primary tubercles. It is very exceptional to see a small secondary in this part of the ambulacra, but they may occasionally replace the normal granules on the larger and primary plates. The large primaries with tubercles commence just above the ambitus, and at a higher level than the great tubercles of the interradia. There is distinct granulation along the median line of the ambulacrum at the ambitus and below, and some granulation just above the pair of large tubercles. The pairs of pores are large, separated by some surface and by a raised, arched, granulate costa.

The interradia, slightly depressed between the ambulacra above the ambitus, are limited there, on either side, by a raised vertical line of furrow, ridges, granules, and small secondary tubercles, and these last become more numerous towards the ambitus. This lateral granulation is comparatively uniform, and may resemble the ornamentation of the interporiferous areas close by. The tubercles at the ambitus are of the same size as those of the ambulacra, and project as much, so that the circumference is circular. There is a considerable large granulation amongst and around the great tubercles of the interradia, and there are small secondaries at the median line as well as near the poriferous zone close by. The crowding of these granules just abactinally to the aboral large tubercles is very decided.

The ornamentation of the disk is in some young specimens very exaggerated.

Dimensions. Breadth 34 millim.; height 20 millim. Breadth 37 millim.; height 22 millim. A half-grown specimen: breadth 26 millim.; height 16 millim.

Locality. Gáj or Miocene series of Sind. Tandra Rahim Khán, west of Sehwan; Naig Nai valley, three miles S.E. of Tóng. Survey numbers G $\frac{226}{49}$, G $\frac{302}{40}$, G $\frac{302}{30}$.

Illustrations of the Species in Plate XLVI.

Fig. 3. The test: natural size.
5. Another test.
6. The apical disk: magnified.
10. The abactinal part of an ambulacrum: magnified.

Illustrations of the Species in Plate XLVII.

Fig. 1. The test, from above.
2. A radial plate: magnified.

3. Cœlopleurus Sindensis, *Duncan & Sladen*. Plate XLVI, Fig. 6 (young form).

Description of a young form, about one half of the size of the matured individual:—

The test is low, nearly flat above, where there is a very slight rise from the ambitus, tumid at the sides, and rounded actinally where the test is narrowed, and is concave, with a reentering surface. The greatest width is above the ambitus and where the slight slope begins to the apex from the sides. From that zone the test slopes very gradually at first to the narrowed surface on which it rests, and then the surface becomes nearly flat, the convexity being but slight towards the small peristome. The outline of the test is nearly circular from above, and there is no projection of the ambulacra at the upper part of the test, and indeed the only elevation there is the raised series of structures that line the interradia near the poriferous zones. The flat ambulacral surface is very well defined, and the angle made by the poriferous zones is not large. The general absence of tubercles of any considerable size above the position of the greatest breadth of the test is very striking.

The apical disk is very developed, and the star-like form, produced by the long basals which trespass upon the interradia very considerably, is well marked. The orifice for the periproct is rather large and circular, and there is no prominent ring-like edge to it. Nevertheless the edge of the periproct is high and the basals slope gradually but decidedly to their adoral ends. The madreporite is in the largest and the perforated portion is restricted to a space aboral to the ovarial pore, and reaching not quite to the anal edge. Between the madreporite perforation and the periproct the surface is ornamented with a few large rounded granules, mixed with some smaller, and all are close and irregularly placed, except towards the radial plate No. III. where there is a slight linear set of granules directed outwards and adorally. The largest of the granules is close to the periproct, and is about mid-distance between the lateral sutures of the basal. The next basal, No. 3, has the same kind of large and small granules as the other, and although they are wanting at the angle beyond the pore, they are in decided oblique rows elsewhere, and the direction of the close granules is outwards and downwards, so as to put the lines of the ornamentation in continuity with that of the radial on either side. There is a relic of a large granule in the same relative position as in the madreporite. There is also a slanting in of the anal edge and an ornamentation of the part. Basal No. 4 is well developed in the specimen, and there is no doubt that in it, as well as in the less preserved basals, the pore is placed on a conical elevation about one third of the whole distance from the angle to the periproct. The ornamentation is of a few separate granules, many of which have become fused, as it were, and are in continuous short oblique lines that have the same relative direction as in the last-mentioned basal. This obliquity is seen on all the basals. The ornamentation of basal No. 1 is very profuse, and there are five rows of oblique sets of large and small granules on one side of the rather tumid plate; the elongation of some of the granules is very distinct. On the other side the ornamentation is less in amount, but is quite as well defined. Nearly twenty granules may be counted on this basal between the pore and the anal edge.

The radials are large, and extend adorally not very far from a circle which might limit the angles of the basals. The radials are broader than high and are pentagonal in shape. The aboral lateral edges are slightly curved, with the convexity in contact with the concavity of the basal on either side. The adoral and lateral sides are short and inclined downwards and inwards, and are not in curves, whilst the lower or adoral edge is broad and arched, with the concavity towards the ambulacrum. This adoral edge is marked centrally with a projection that reaches a little adorally, and is in the median line of the commencing ambulacrum. This projection covers the position of the exit of the optic nerve, as is usual in the *Cœlopleuri*, and as the plate is not superficially perforated there is reason to believe that the nerve was divided, as in the recent *Arbacia*, according to Lovén. The projection is continuous with a ridge made up of more or less coalesced small granules, which divides the surface of the radial from the apical angle of it downwards. Several more or less distinct ridges and intermediate grooves pass from this ridge obliquely outwards and apically, and others are parallel with the free sides of the plate, and reach the concave adoral edge. This oblique ornamentation is more or less continuous with that of the basal plates in direction. There are usually two of these oblique ridges very well seen; but there is some variation on different plates in the strength of the ornamentation, and even the central ridge may be absent. The adoral third at least of the free edge of the radial plate is in relation with the apical end of the ridge of granules and very small tubercles which bounds the ambulacrum, and ornaments the outer third of every interradial plate towards the apex.

The ambulacra are not so broad as the interradia. Above the area of the great tubercles the interradia are only very slightly depressed below the level of the ambulacra, and these are very slightly tumid. It has been already noticed that the angle formed by the poriferous zones at the radial end is narrow, and in fact the interporiferous area is not broader than the poriferous zone at the level of the eighth pair of pores. In ambulacrum No. III. the breadth does not increase decidedly until the tenth or eleventh poriferous plates, and they are the first of triplets on which a large tubercle is placed. The breadth is greatest where the tubercles are the largest, and it diminishes towards the peristome. Here the breadth is nearly equal to that at the tenth pair on the abactinal surface, and the margin of the ambulacrum is a double adoral curve between the small and broad branchial cuts. This part projects into the peristomial space more than the interradia, and there is a concavity at the median line of the ambulacrum, the edge of which is separated from a large sphæridium pit by a very slender horizontal process, which is between the last of the small tubercles. There are seven large tubercles in one ambulacral zone and eight in the other, and of these three are very large and projecting. The rest are smaller, and diminish in size to the peristome. But above the upper large tubercle there is scarcely any development of tubercle, for although the plates are arranged as in the species in which there are well-developed tubercles in the abactinal part of the ambulacrum, the tubercles are either ill developed or are rudimentary.

The following is the order of the succession of the plates in ambulacrum III.:—

Zone "*a*"—1, small primary.
2, small „
3, small „
4, small „
5, small „
6, large „
7, large „
8, small „
9, small demi.
10, small „
11, large primary.
12, small demi.

Zone "*b*"—1, small primary.
2, small demi.
3, large primary.
4, small „
5, large „
6, small „
7, small „
8, small „
9, large „
10, small demi.
11, small „
12, large primary.
13, small demi.

Taking row "*a*," the small tubercle-bearing plates are 6 and 7, and the first large tubercle is composed, really, by plates 10, 11, and 12, these being a large primary between two demi plates.

The plates 6, 7, and 8 are very instructingly placed, for they form a triplet of three primaries without any demi plates, as in the instance of the combinations of two demi plates and a middle primary to form the great tubercles lower down. It is evident that the crowding and resulting pressure produce the demi plates, and that the fusion more or less of the ornamentation of the triplet develops the great tubercle. The original tubercle-bearing plate, although enlarged by the accession of the demi plates, retains the greater part of the boss and all the mamelon. The tubercles of the plates marked "small" are little more than large granules, and hence the non-tuberculate nature of this part of the ambulacrum of the species.

On zone "*b*" the first large tubercle is on a triplet of Nos. 11, 12, and 13, and 12 is the large primary, the others being demi plates. But 8, 9, and 10 form a triplet, and it will be noticed that the highest plate is not a demi but a small primary. Thus growth and pressure affected the lower member of the combination and not the upper one, and the lower became a demi plate, being cut off from the median line. In the triplet of plates 4, 5, 6, there is no demi plate, but a central large one and an upper and a lower small plate, all being primaries, however. But the crowding-in of the two upper plates, or 1, 2, after a large plate, for that part of the ambulacrum, caused plate 2 to become a very small demi.

With regard to the ornamentation of the ambulacra at the ambitus, it may be noticed that the great tubercles have a scanty line of large granules along the line of the median suture. These granules become rarer higher towards the apex.

The granules are very scanty on the highest large tubercular plate, and a few are seen on the aboral margin of the plate.

The usual number of large primary tubercles, the result of the combination of three plates, seen on an ambulacrum is fifteen, there being eight on one zone and seven on the other.

Above the highest large tubercle there are some small and rudimentary ones on the larger of the ambulacral plates within the poriferous zones. Quite at the peristome the last three triplets have their pairs of pores remote from the outer suture of their plates, and the outer region is a part of the tag-like surface which is continued from the fairly well-marked cut on either side of each ambulacrum.

The interradia are deprived of large tubercles above the commencement of the upward-sloping part of the test, and the highest of the large tubercles is at a lower level than the corresponding one of the ambulacrum. In an interradium which is well preserved (No. II.), the plates are broader than high, and their sutural lines are grooved; the transverse direction of the plates is decidedly oblique, and rather more so than the direction of the line of the pores close by. The smallest plate at the edge of the apical disk is plate 1 of zone "*a*," and the first rather large tubercle is on plate 6; on zone "*b*" the similar tubercle is on plate 5. Both much smaller than a typical great tubercle, do not cover much of their plate, and have a smaller tubercle close to their bases and nearer the median line. The rest of the plates is well granulate, and the granules of the plate of "*b*" are rather disposed to be in transverse lines. On the outer edge of the plates, and where there is a continuation of the line of structures that bounds the poriferous zones of the ambulacra, there is a number of small tubercles arranged in three vertical rows. These small tubercles are not very close and are mammillate, one being, moreover, larger than the others. It is this part of the plate which is decidedly oblique. The plate "*a*" 5 from the apex, has the relic of a small tubercle near the median and adoral angle; the granulation is small and linear and the direction is oblique to the line of the edges of the plate, and somewhat continuous with that of the plate just described from zone "*b*." There are two vertical rows of small tubercles close to the outer margin, and one tubercle is slightly larger than the others, which are also circumferential to it. Plate 4 of zone "*b*" resembles the last plate in the arrangement of its lines of granules in ridges, and in the existence of a degraded small tubercle on the inner and adoral angle; moreover the arrangement of the small tubercles on the outer edge of the plates is the same.

The other plates are free from vestiges of tubercles, and the inner region of each has two irregular rows of very small tubercles.

The aboral edges of the larger primary tubercles of the interradia above the ambitus are ornamented with a row of distinct granules, and there are similar rows adorally. There is much granulation in the median line, and finally the granulation amounts to small tuberculation on the outer edge of each plate, where there are two and in some plates three little tubercles in a vertical or very oblique row. There are four very large and four rather large primary tubercles in an interradium.

Illustration of the Form in Plate XLVI.

Fig. 6. The apical disk: magnified.

Family TEMNOPLEURIDÆ.

Genus TEMNECHINUS, *Forbes*, 1852.

The great collections of the species of this genus, which we have shown to be synonymous with *Temnopleurus*, as used by d'Archiac and Haime, came from Kachh and Kattywar, and the paucity of forms in the collection of the Indian Geological Survey from Sind seems to strengthen this opinion. Two new species are amongst the collection from Sind, and their Tertiary Australian facies is remarkable.

1. **Temnechinus Rousseaui**, *d'Archiac & Haime*, sp. Plate XLVII, Figs. 3 & 4.

The reasons for placing in the genus *Temnechinus*, Forbes, the species described and named *Temnopleurus Rousseaui*, d'Archiac & Haime, have been given in the 'Monograph of the Fossil Echinoidea from Kachh and Kattywar,' pp. 51, 56, and 84, Pal. Indica, Ser. XIV.

A much-worn specimen of *Temnechinus Rousseaui*, d'Archiac & Haime, sp., is in the collection from the Gáj or Miocene deposits of Sind, and it belongs to the depressed variety. We have figured the shape of the part of the test which remains, and also a magnified view of the ambulacral and interradial plates close to the peristome.

Locality. Entering the hills on the road from Jangri to Búla Khán's Thána. Survey-number G $\frac{280}{28}$.

Illustrations of the Species in Plate XLVII.

Fig. 3. The test: natural size.
4. The interradium and ambulacrum (near the peristome): magnified.
12. A plate and part of the corresponding ambulacrum: magnified.

2. **Temnechinus affinis**, *Duncan & Sladen.*

The interesting species which we described from a well-preserved specimen from the Miocene of Kattywar is represented in the Gáj series of Sind. The remarkable ornamentation shown in the illustrations of the species in plate xiii, figs. 11 & 12, of the 'Fossil Echinoidea of Kach and Kattywar,' Pal. Indica, Ser. XIV, is indicated in a worn and badly fossilized specimen from Sind. The specimen from this last locality has the poriferous zones more sunken than in the type; but this hardly seems to be of classificatory value. We do not illustrate the specimen, as it is not sufficiently well preserved, but simply refer to the illustration already alluded to.

Locality. Gáj or Miocene series of Sind. Entering the hills on the road from Jangri to Búla Khán's Thána. Survey-number G $\frac{280}{28}$.

There is a solitary specimen of a regular Echinoid which has lost the apical disk, but which otherwise is well preserved. It has the facies of *Lepidopleurus* (page 306), but the peculiar shape of the coronal plates is not seen. On the contrary, there are indications, from the position of the transverse sutures, that the form has the usual, nearly rectangular, plates of *Temnechinus*.

Were the form more depressed than it is and somewhat polygonal in the outline of the ambitus, the considerable resemblance of it to *Temnechinus lineatus*, Duncan, of the Australian Tertiary deposits would be very striking. But, although clearly distinct specifically, the two forms are closely allied.

3. TEMNECHINUS STELLULATUS, *Duncan & Sladen*. Plate XLVII, Figs. 8 & 9.

The test is turban-shaped and broader than high, the tumid condition of the ambitus is noticed also higher up, and the shape is not remote from the hemispherical. The actinal surface is rather flat, and there is some concavity at the small circular peristome. The ambulacra are narrow, rather tumid from side to side, and the poriferous zones are very slightly sunken and narrow. There is a vertical row of small primary tubercles on each side of the ambulacrum, close to the poriferous areas, and the tubercles have a small imperforate mamelon, and an expanded, low, but tumid base, the edges of which are either circular or incised here and there. Costa-like narrow and separate processes pass from the edge of the base of the tubercles, principally adorally, to reach the small rounded granules which are on the plate placed adorally to the tubercle-bearing one. Others, which are very short, arise from the inner part of the edge of the base, and pass to the granules close to the inner side of the tubercles; and sometimes there are two or three processes that have an aboral course to reach the two or three granules placed between the successive tubercles. The tubercles are placed so close to the poriferous zone that there are no intermediate granules, and the poriferous zones seem to be well defined from the interporiferous. Between the rows of the primary tubercles and the granules immediately associated with them is a rather confused ornamentation of small granules, more or less united together by radiating and very thin costa-like processes, giving a stellate appearance. A few large granules are mixed up in this ornamentation and add to the confused appearance. Near the apical end of the ambulacrum there is often a tubercle surrounded by a ring of granules, each of which is connected with it by a radiating process.

The interradia are slightly sunken along the median line, and the plates are rectangular, and not very high. A row of small primary tubercles, slightly larger than those of the ambulacra, is placed vertically on either side of the median line, and there is a tubercle on the centre of each coronal plate. Each tubercle has a small imperforate mamelon, a broad, flat, and tumid base, and radiating from it numerous processes pass to an encircling series of granules. Usually these short costa-like processes do not pass from the tubercle of one plate to that immediately above or below, but the straight close processes stop at the transverse suture; nevertheless near the abactinal part of the interradia this junction may exist. There are two or three rows of granules placed between the tubercles and the poriferous zones. Between the rows of tubercles, and especially close to the median line, there is much small granulation, and the irregularly disposed granules are united by short, slender, and straight processes. In some places this stellate arrangement is seen amongst the granules of the space between the tubercles and the poriferous zones. There is no distinct costulation of or radiating appearance on the poriferous part of the ambulacral plates.

Dimensions. Height of the test 9 millim., breadth 18·8 millim.

Locality. The Gáj or Miocene series of Sind: Mazaráni Nai. Survey-number G $\frac{298}{5}$.

Illustrations of the Species in Plate XLVII.

Fig. 8. The test: natural size.
9. Part of an ambulacrum and interradium: magnified.

4. Temnechinus Gajensis, *Duncan & Sladen.* Plate XLVII, Figs. 10 & 11.

The test is small, turban-shaped, flat abactinally and actinally, and the peristome is slightly depressed.

Apical disk wanting.

Ambulacra narrow, flush, and with slightly sunken poriferous zones with simple pairs of pores. A vertical row of small primaries, with small imperforate mamelons and broad bases, is close to the poriferous zone on either side. The successive tubercles are separated by a transverse row of two or three granules, and are connected with the tubercles of the opposite side of the ambulacrum by lines of granules placed on radiating narrow ridges, with varying amounts of space between them. Hence the surface of the ambulacra is covered with a raised ornamentation of a simple character, and it is connected with that of the interradia by means of costal ridges which cross the poriferous part and are continued on to the interradial area so as to join corresponding processes coming from the bases of the primary tubercles.

The interradia are broad, and have a somewhat depressed median line. The ornamentation resembles that of the ambulacra; but the primaries are in two rows only along the line of the centres of the plates, and are connected by long, radiating, granular, narrow, rounded ridges, between which there is, in some places, a little space so as to show parts of the test. Usually the test is well covered by the radiating granular ridges.

The peristome is small and nearly circular.

Dimensions. Height of the test 5 millim.; breadth 9 millim.

Locality. The Gáj or Miocene series of Sind: Naig Nai valley. Survey-number G $\frac{301}{40}$.

Illustrations of the Species in Plate XLVII.

Fig. 10. The test: natural size.
11. An ambulacrum and interradium, in part: magnified.

Unfortunately there is only one specimen of this species in the collection, but it is very well marked by the peculiar series of small primaries in the interradia and ambulacra, and by their simple radiations of coalescing ridges and granules. There is little or no difference in size between the tubercles of the two areas. The absence of the apical disk is to be regretted.

Genus LEPIDOPLEURUS, gen. nov.

Test small, broader than high, nearly hemispherical or turban-shaped. Apical system large, solid; basals alone enter the anal ring, and are long vertically; radials perforated at their adoral edge. Ambulacra small; poriferous zones slightly sunken, pairs in simple series. Interporiferous spaces crossed by a zigzag of raised granular ridges uniting the opposite tubercles. Interradial plates angular, with the adoral edge overlapping and occupying a corresponding cavity in the aboral edge of the plate below. Two vertical rows of tubercles, and the tubercles of each row are connected by vertical and narrow ridges. Peristome and cuts small. Ambulacral plates in triplets, the aboral plate of the composite plate being a low primary; the next below is a demi plate, very small, and crowded out of the line by the succeeding or adoral primary, which has an expanded interporiferous part.

Tubercles imperforate and not crenulated.

The angularity and scale-like appearance of the interradial plates, the ridges between the tubercles, and the sunken sutural lines separate this genus from the others of the Temnopleuridæ.

There are two well-marked species of the genus in the Gáj Tertiaries.

1. LEPIDOPLEURUS HEMISPHÆRICUS, *Duncan & Sladen*. Plate XLVII, Figs. 5, 6, 7.

The test is small, nearly hemispherical, slightly broader than high, rather flat at the apex, and moderately concave actinally. The apical system is large, flat, and not projecting, solid, and has a wide ring of basals and radials, the last not entering the circumference of the round and open periproct. The basals alone form the anal ring, and they are large, slightly unequal in size, the madreporite being the largest; there is an adoral angle and seven sides to each plate, the edge in contact with the periproct being one of them. The height of the plates is greater than their breadth at the periproct, and the ovarial pore is large and near the adoral angle. The madreporite has no pore, and the spongy surface is decidedly convex. The sutures of the plates are very distinct, and the slope of the surface of the whole system from the faint ring round the anus to the adoral angles of the basals is slight.

The radial plates are broader than high, widely separated from the periproct, and are more or less irregularly triangular in outline. The adoral edge of the radial plate is broad, and has a projection at the median line, on either side of which there is a curved edge, the concavities of the curves looking towards the ambulacra. The optic pore is at the base of this projection.

The ambulacra are narrow, petaloid above, open actinally, and they are about one half of the width of the interradia at the equator; but at the peristome the breadth of the ambulacra is only a little less than that of the interradia. The surface of the ambulacra is flush with the rest of the test, but the poriferous zone is rather sunken. The pairs of pores are in a simple vertical line, and, although the pairs combine to form triplets, any arching is exceptional; no doubling of the pairs ever occurs. The pairs of pores are rather large for the narrow zone, are wide apart, and unequally so on account of the different sizes of the plates in a triplet. Well-preserved plates show a transverse ridge or narrow rounded-off costa placed aborally with regard to the pair of pores of each plate, and passing not in quite parallel lines from a primary tubercle, or from a large granule in the interporiferous area, to large granules or small tubercles in the interradia. As a rule, two of the costæ of a triplet arise from the two adoral plates of the triple combination, or from the part of it which carries the primary tubercle, and one from the aboral member of the triplet, which usually has a large granule on it. There is a vertical row of primary tubercles close to the poriferous zone on either side in the interporiferous areas, and the consecutive broad-based, small-topped tubercles are separated by one or by two large granules. The small mamelon of the tubercle contrasts with the broad sloping boss; there is no perforation, and crenulation does not occur. But the edge of the expanded base is often indented, for there are the costulate processes which unite the base with the costæ over the poriferous zone, and there are sometimes others in the opposite direction, which connect the base with small granules on the same ambulacral plate. Midway between the apical system and the peristome there is, now and then, an extension of a costulate process from the base of one ambulacral tubercle to that of its fellow of the opposite side of the interporiferous area. Here and there there are two large granules, placed transversely, between each tubercle in vertical succession. But near the peristome the oblique costulation over the plates of the interporiferous areas is not seen, and the presence of the pair of intermediate granules is invariable. The ornamentation of this part consists of a small primary tubercle followed by two granules, and this being repeated several times is very characteristic. The arrangement of the ambulacral plates is near the radial end in low primaries, but a little adorally it is in triplets; the aboral plate of each combination is a low primary plate (that is to say, it reaches the median line) with a slight expansion of the interporiferous portion, and this part carries the granular ornamentation. The next plate, which is of course placed actinally, is a small demi plate, and it is followed adorally by a primary which has a great internal expansion and which prevents the plate immediately above, that is to say the demi plate, from reaching the median line. The last two plates carry the primary tubercle.

The plates of the ambulacra are therefore very dissimilar, appear crowded, and the sutures are rather sunken and distinct.

The interradia are remarkable for the angular shape of the adoral edge of the coronal plates, the corresponding aboral parts being indented. The appearance given is that of scale armour, and it diminishes below the equator, where the plates become broader, and not so high as they are near the apical disk.

The sutural lines of the plates are sunken, and the ornamentation is raised, there being a groove on each plate just below the aboral edge in the median line; whilst the primary tubercle of each plate is in the median line of the plate, and rather towards the adoral edge. Nearer the peristome, and where the plates are lower but broader, the tubercle is at about the centre of the plate.

The edges of each plate are ornamented by a few small secondaries with boss and mamelon, and there are usually at least three of these near the poriferous zone, and they are connected with the costulation of the poriferous plates as already noticed. Other small tubercles are near the median suture, and they are not connected by ridges with the corresponding parts of the opposite coronal plates; but the small tubercles which are placed near the adoral and the aboral edges are connected with the large primary by means of narrow convex ridges separated by still narrower deep and linear grooves or spaces, and this, more or less, vertical series of ridges may even extend from the tubercle of one plate to that of the plate above or below. As a rule, the ridges stop at the transverse sutures. Above the equator there is a triplet of ambulacral plates in contact with each interradial plate.

The peristome is small, nearly circular, and there are no cuts.

Dimensions. Height 8 millim., breadth 11 millim.

Locality. The Gáj or Miocene series of Sind: Naig Nai valley, 12 miles south of Sháh Rhúi. Survey-number G $\frac{302}{40}$.

Illustrations of the Species in Plate XLVII.

Fig. 5. The test.
6. Part of the abactinal surface: magnified.
7. Part of the ambitus: magnified.

2. LEPIDOPLEURUS GRANULATUS, *Duncan & Sladen.*

The test is turban-shaped, broader than high, tumid close above the ambitus, sloping without a bold curve to the apical system, and swollen actinally, but concave at the small, nearly circular, and very minutely incised peristome.

The apical system is slightly projecting above the ordinary curve of the test; it is solid and rather large, the height of the basals from their adoral angle to the periproct being well developed. The periproct is surrounded by a decided ridge, and is not large. The basals have the pore large and near their adoral angle, and the madreporite has its surface swollen and raised above the level of that of the other basals. It has a pore beyond the spongy part and close to the angle. The radials are broader than high, are tumid adorally, and there are the relics of a minute granulation upon them. The optic pore is close to the adoral margin.

The ambulacra are narrow, flush with the rest of the test; but the poriferous zones are sunken slightly and narrow. The pairs of pores are nearly in straight series, and are only slightly in simple ill-defined arcs, or in successive series of oblique triplets. There is no doubling of pairs; and near the peristome the breadth of the ambulacra is small, and a little less than that of the interradia. The breadth of the ambulacra, a little above the ambitus, is considerably less than the interradia there. There is a vertical row of small primary tubercles on each side of the interporiferous area, close to the pores, and the tubercles are with a broad base which slopes up gradually to the small imperforate mamelon. In the space between the consecutive tubercles there is a row of two or three rather large granules in a transverse row. Between the tubercles and along the median line of the area there are a few rather indistinct large and small granules united to the base of the great tubercle by costa-like ridges. Some granules situated at the actinal and abactinal edges of the plates are often connected to the tubercles by the ridges.

The arrangement of the tubercle-bearing triplet of ambulacral plates is as in the generic definition.

The interradia are broad between the apex and the peristome, and the plates of the part above the ambitus are with a median and adorally projecting angle, the usual generic scale-like appearance being very decided when there has been some weathering. The sutures are distinct and sunken, and the primary tubercles are in a vertical row, there being a tubercle in the centre of every one plate of the interradia, with a large base and a small mamelon. Just above the ambitus the rest of the plate unoccupied by the large tubercle is closely packed with rounded granulations, some of which are between the poriferous zone and the tubercle. These last are united to the small costæ of the poriferous zone. At the actinal surface the great tubercle of a plate has the granules more or less in ill-defined circles around it, and there is often a costulation between them. The tubercles of the interradia are rather larger than those of the ambulacra; but both sets are small. The radiation of the costa-like processes is often visible from a tubercle close to the peristome to the granules between it and the poriferous zone of the ambulacrum. There are fifteen plates on one side of an interradium, and three times that number of large and demi plates belonging to the ambulacra.

Dimensions. Height 7 millim., breadth 11 millim.

Locality. The Gáj or Miocene series of Sind: Mazaráni Nai. Survey-number G $\frac{298}{5}$.

The arrangement of the plates of the interradia and ambulacra, the character of the apical disk, the small peristome with very slight cuts, the sunken sutures seen in some places, and the costa-like union of the tubercles and granules link this form with the last.

The distinctions of a specific character are the multigranular plates above the ambitus without costal unions, the simpler ornamentation of the ambulacra in the median line, and the presence of a third intermediate granule. The shape of the test also adds to the differences between the two species.

Subfamily TRIPLECHINIDÆ.

Genus HIPPONOË, *Gray*, 1840.

(*Syn.* Tripneustes, *Agassiz*, 1841.)

Test of large size, tumid, and often subconoid.

Ambulacral areas very broad, nearly equal, or subequal, to the interradial areas. Poriferous zones very wide. Pores arranged in three distinctly spaced vertical series, the external ones regularly vertical, the median series sporadic.

Primary tubercles imperforate and not crenulate, small and numerous, arranged in horizontal rows in the interradial areas, forming also more or less regular vertical series. Small secondary tubercles distributed between the three vertical rows of pores.

Peristome small and subcircular; with deeply indented mouth-slits.

1. Hipponoë proavia, *Duncan & Sladen*. Plates XLVIII & XLIX, Fig. 1.

The test is of large size, and was probably circular in marginal contour, slightly depressed, the height being a little more than two thirds of the diameter; convex abactinally and probably with a tendency to become conoid towards the apex; with great tumidity at the ambitus, which passes gradually over on to the actinal surface, where the test is slightly concave.

Ambulacral areas remarkably broad, their width at the ambitus being greater than that of the interradial areas; and they are flush with the general surface of the test. The poriferous zones are straight and of great breadth, being a shade broader than the width of the interporiferous area; thus at the ambitus of the large type specimen the breadth of the interambulacral area measures 49 millim., the whole ambulacral area 50·75 millim., and the poriferous zone 17 millim. The pores form three distinct, vertical, and widely spaced series; the inner and the outer row are almost regularly uniserial, whilst the disposition of the pores in the median series is more or less sporadic, with a tendency to fall into oblique triplets. The manner in which this arrangement is effected, and the position of the pairs of pores upon their respective plates will be readily seen on referring to Fig. 4.

The ambulacral plates are very short, their height being not more than one tenth or one twelfth of the breadth, and each is normally composed of three poriferous plates, each of these contributing a pair of pores to one of the three vertical series above described. Their arrangement is after the following manner:—The inner end of each ambulacral plate, which occupies the interporiferous area, is composed of what we may speak of as the primary poriferous ossicle; passing the eye along the aboral margin of the plate, and traversing it from the inner extremity of the line outwards, it will be noticed that as soon as the poriferous zone is reached the aboral margin commences to be gradually scooped away, this part of the plate being, along the greater portion of the breadth of the poriferous zone, a mere thin band, less than one third the height of the compound plate. The portion thus scooped away is occupied by two low demi poriferous plates in the form of band-like wedges. At the outer end of the composite ambulacral plate it will be noticed that the median plate of this triplet is the highest (*i. e.* forms the broadest band); this is the most adoral of the two demi poriferous plates, and the one which is immediately superposed on the primary poriferous plate; its pair of pores, which are borne close to the outer end, go to form the outermost of the three vertical rows in the poriferous zone. The second demi poriferous plate is the most aboral of the triplet, and bears near its median region the pair of pores which fall in the median or sporadic vertical series. The primary poriferous plate (the most adoral plate of the triplet) bears the pair of pores which stand in the inner of the three vertical series of the poriferous zone, and are situated rather nearer the centre of the plate than one third of the distance from the inner to the outer end. On carefully examining an ambulacral area it will be observed that not infrequently one ambulacral plate (*i. e.* a composite triplet, as above described) simulates the character of a demi plate in relation to the next adorally adjacent ambulacral plate, in so far that the breadth of the "simulating" triplet is reduced from the adoral margin on the inner part of the plate, the part thus apparently cut away obliquely being occupied by the increased primary poriferous plate of the subjacent triplet; the whole of the upper of these two ambulacral plates thus simulating the character of a simple demi poriferous plate in an Echinoid triplet, relatively to the underlying (*i. e.* more adoral) ambulacral plate. Occasionally the increase of the one primary poriferous plate to the sacrifice of the primary of the next aboral plate (*i. e.* triplet) is so great that this latter is excluded altogether from reaching to the median suture of the interporiferous area. At first sight these plate arrangements are very puzzling, and need careful study before they can be traced. The various features mentioned above are represented in Fig. 4.

The primary tubercles which ornament the plates are small, subequal, imperforate, and non-crenulate; and those of the ambulacral regions are very little smaller than those of the interradial areas. On the interporiferous areas there are six vertical rows of primary tubercles, which also form regular horizontal rows of three; these are equidistantly spaced and disposed in the following noteworthy manner:—The two tubercles nearest the poriferous zone stand on the same primary poriferous plate, whilst the third tubercle, which is next to the median suture, is placed on the next aboral primary poriferous plate. The succeeding aboral primary poriferous plate bears no tubercles; and this disposition is maintained very prevalently throughout the right-hand column of the ambulacral area. In the left-hand column the three tubercles often form an oblique series, with a tubercle on each succeeding plate; and very frequently the posture of the respective tubercles seems singularly independent of the plates, in being placed either midway on the horizontal suture, or with the boss only encroaching more or less on the neighbouring plate. This slight but remarkable diversity in the arrangement of the tubercles of the interporiferous area in the right-hand columns of the ambulacral area is to be seen in all the ambulacra which we have been able to examine in the example under notice. In the poriferous zones there are three vertical rows of tubercles of the same size as those in the interporiferous area. Two of these are located between the outermost and the median vertical rows of pores, whilst the third is between the median and the innermost vertical series of pores. The vertical rows are maintained with great regularity, but there is considerable irregularity in the respective posture of the tubercles of the two rows between the outer and the median series of pores. Frequently two of these tubercles stand in horizontal line, and are well spaced from the next pair, but frequently the tubercle of one vertical row is not in horizontal line with the corresponding tubercle of the other. The tubercles which stand between the median and the inner vertical series of pores appear to be placed regularly opposite the interspaces between the tubercles of the innermost of the two vertical series of tubercles which occupy the space between the outer and the median series of pores, and are also in horizontal line with the nearest tubercle on the interporiferous area. In addition to these primary tubercles a few small miliary (but still mammillated) tubercles occur irregularly upon the ambulacral plates. There are five ambulacral plates opposite one of the interradial plates at the ambitus, and consequently five of the pairs of pores belonging to the outer vertical series.

The interradial plates are broad but short, their breadth at the ambitus being more than five times the length, the actual dimensions being 25 millim. and 4·5 millim. respectively. Each plate bears a horizontal line of uniform and equal-spaced primary tubercles, slightly larger than those on the ambulacral areas. In the neighbourhood of the ambitus there are seven tubercles in this horizontal line, the position of which upon the plate is rather below the middle. At the end of the plate adjacent to the poriferous zone an additional primary tubercle of equal size to those described stands near the aboral margin of the plate, immediately over the interspace between the two first tubercles of the horizontal line, there being thus eight primary tubercles on each plate at the ambitus; as the plates recede from the ambitus, however, the tubercles of the horizontal series nearest the poriferous zone diminish to the size of mere secondary tubercles, or disappear altogether, which causes the horizontal line of tubercles to appear to take a sharp angular bend at the extremity near the poriferous zone. Sometimes in the larger plates near the ambitus there is a small secondary tubercle in the extreme aboral corner of the plate, close to the poriferous zone; and an irregular line of mammillated miliary tubercles stands on the aboral margin, whilst a few irregularly disposed and very much smaller simple miliary granules are distributed on the vacant portions of the plate.

Unfortunately neither the peristomial nor the apical regions of the test are preserved.

Remarks. We refer to this species, although with some doubt, a fragment, consisting of part of an interradial and an ambulacral area. It belonged to a much smaller test than the type-specimen above described. The interradial plates at the ambitus bear a horizontal row of five primary tubercles and a distinct line of miliary tubercles along the aboral margin, the one nearest the poriferous zone being the largest of these. The tubercles are more numerous and much more closely placed than in considerably larger examples of the allied species *H. antiqua*, described below; and on these grounds we consider it probable that the fragment belonged to a young test of *H. proavia*. The fragment in question is figured in Plate XLIX.

Dimensions. The large type specimen measures 185 millim. in its greatest diameter, and 146 millim. in the lesser diameter. It has been crushed laterally. The height of the specimen in its present condition is 98 millim., and, as far as can be judged, the test when perfect was not much higher.

Localities. In the Gáj series of strata:—i. Mendiári, thirty-five miles north of Karáchi. Survey-number G $\frac{302}{46}$.

ii. Ravine on the south-east of Bill, twelve miles north of Sháh-beg (the coral zone). Survey-number G $\frac{302}{43}$.

Illustrations of the Species in Plates XLVIII. & XLIX.

Plate XLVIII.

Fig. 1. Profile view of the test: natural size.
2. Actinal view of the test: natural size.
3. Interradial plates, to show ornamentation: magnified.
4. Part of the ambulacral area to show the composition of the plates: magnified.
4 *a.* Diagrammatic sketch of ambulacral plates, to show the disposition of the ornamentation: magnified.

Plate XLIX.

Fig. 1. Fragment of a small test, probably belonging to this species: natural size.

2. HIPPONOË ANTIQUA, *Duncan & Sladen.* Plate XLIX, Figs. 2–4.

The test is usually of a medium size, but attains, when well grown, rather large dimensions. Its form appears to be subject to great variation, some specimens being considerably depressed and with the abactinal surface more or less conoid; whilst others are much higher, decidedly tumid at the sides, and with very little, if any, trace of the conoid form towards the apex. The first-mentioned forms appear to be chiefly large examples, and the more globular tests the smaller ones. It is, however, difficult to indicate with certainty the shape of the test, as all our examples are either crushed or fragmentary; the species may be said with safety to be extremely variable in many points, like its modern representatives.

The ambulacral areas, which are flush with the general surface of the test, are of great breadth, their width at the ambitus being only a little less than seven tenths of the width of the interradial areas; they contract gradually towards the apex, where their outline becomes narrow and pointed. The poriferous zones are straight and of great breadth, being nearly as broad as the width of the interporiferous area; thus at the ambitus of the largest specimen the breadth of the interradial area measures 43 millim., the whole ambulacral area 29 millim., and the poriferous zone 9 millim. The pores form three distinct, vertical, and well-spaced series. The pores of the inner row are regularly uniserial. The disposition of the pores of the median series is sporadic, with a slight tendency to form oblique triplets, the feature being specially noticeable at the ambitus, and becomes much less regular on the upper part of the series. The outer series of pores are nominally uniserial, but show slight irregularities here and there, and do not form quite as strictly regular a vertical line as the inner series. The ambulacral plates are very short, their height being not more than from one tenth to one twelfth of the breadth; and each is composed of three poriferous plates, the adoral one a large primary, and the other two low band-like demi plates, each of these contributing a pair of pores to one of the three vertical series above described. The general character and the method of the arrangement of the poriferous plates accords so closely with those of *H. proavia*, which we have discussed at length on the preceding page, that it is unnecessary to again describe them in detail. It is interesting, however, to note in this species, in the neighbourhood of the ambitus of the large specimen, that what might be considered as the true compound ambulacral plates, from their appearance and the posture of the zigzag suture in the median radial line, are in reality composed of three compound ambulacral plates, which individually simulate primary poriferous plates; these apparently true compound ambulacral plates being, in other words, built up of three triplets of poriferous plates. Each of the three compound ambulacral plates which simulate primaries extend up to the median suture; but the middle "compound" of the trio is the largest at the inner end, expanding in depth as it approaches the median suture, and causing a corresponding diminution there of its ad- and aboral companion compound plates which simulate primaries. In the large specimen under notice this character may be traced throughout the greater portion of the ambulacrum, though in the upper region it is sometimes indistinct and sometimes interrupted altogether, the zigzag median suture being very slightly bent and irregular.

The primary tubercles which ornament the plates are small, subequal, imperforate, and non-crenulate; and those of the ambulacral areas are very little smaller than those of the interradia. On the interporiferous areas there may be said to be four vertical rows of primary tubercles; but these do not form horizontal rows, and only the two outer rows are strictly regular; the tubercles of the two inner rows are much less numerous and alternate with one another, and are often smaller than the tubercles of the outer rows. Two or three compound ambulacral plates stand between each of the tubercles which form the outer vertical series; and the inner series of tubercles are almost always borne on these intermediate plates, and not upon the same plate as the outer tubercle. The inner tubercles scarcely extend further than midway between the ambitus and the apex, the outer series only reaching the apex and the peristome.

There are nominally two vertical series of tubercles in the poriferous zones: one, which is the most regular, being situated between the outer and the median vertical rows of pores; whilst the other is in the much narrower space that intervenes between the median and the innermost vertical series of pores. Much irregularity occurs in the spacing of these tubercles and in their size, and numerous small miliary tubercles are interspersed. There are four ambulacral plates opposite one of the interradial plates at the ambitus, and consequently four of the pairs of pores belonging to the outer vertical series.

The interradial plates are broad but short, the breadth at the ambitus being rather more than four times the length (*i. e.* depth), the actual dimensions being 21·5 millim. and 4·75–5·0 millim. respectively. Each plate bears a horizontal line of uniform and widely-spaced primary tubercles, very slightly larger than those on the ambulacral areas. In the neighbourhood of the ambitus there are four tubercles in this horizontal line, the position of which upon the plate is rather below the middle. At the end of the plate adjacent to the poriferous zone an additional primary tubercle, of equal size to those described, stands near the aboral corner of the plate, and there are thus five primary tubercles on each plate at the ambitus; this additional upper tubercle, however, is not found on more than five or six plates above the ambitus, and on the upper ones even of these becomes reduced in size to a small secondary. The first tubercle of the true horizontal series (next the poriferous zone) does not extend beyond two thirds of the distance between the ambitus and the apex, and it is the second tubercle only whose series extends from the peristome to the apex, this tubercle being the sole occupant of the five or six upper plates of the interradial area; the third tubercle extends about as far as the first above mentioned, but appears to maintain its size better, the tubercles of the first series diminishing rapidly as they approach their upper limit. The fourth or innermost tubercle does not extend much beyond halfway between the ambitus and the apex. Consequent on this disposition of the tubercles, there is a median naked and slightly depressed or trough-like area in the uppermost region of the interradia. A number of widely-spaced miliary tubercles are present on the plates, and a more or less definite horizontal series occurs along the aboral margin of the plates, at least near the ambitus and a little below.

The peristome is tolerably wide, decagonal, impressed, with the actinal surface swelling tumidly between the peristome and the margin of the test; and the diameter is a little more than one fourth that of the test (23 millim. in a specimen whose diameter is 80 millim.). The mouth-slits are deeply cut, and extend as far as the level of the fourth tubercle in the ambulacral area. The notches are narrow and have a conspicuous raised rim, most prominent on the interradial side, where there is also a considerable thickening near the upper third of the length; this causes the notch to have a slightly curved appearance, as if bending towards the interradium. On its embouchure into the peristome the notch expands rather rapidly, its interradial side being more cut away than the ambulacral. The peristomial margin of the ambulacral areas is nearly straight, very faintly indented at the median line, and is nearly twice as broad as the interradia.

The apical disk is not preserved in any of our specimens.

Young form. A small test, 56 millim. in diameter and 40 millim. in height (slightly crushed), presents all the characters of the adult form in the structure of its ambulacral areas, and is unmistakable. The specimen unfortunately is so badly preserved and so much destroyed by weather-action, that it is quite unfitted for description.

Variations. Reference has been made to the variability of the form of the test of this species. The general type may be said to be depressed, with the abactinal surface subconoid, suggesting the habit of the recent *Pseudoboletia.* Examples of this form bear the Survey-numbers G $\frac{302}{20}$, G $\frac{304}{14}$; and a smaller specimen, which perhaps may be classed in the same category, is marked G $\frac{304}{10}$. A relatively higher and more globular test, of smaller size than the type, is marked G $\frac{302}{20}$ and G $\frac{302}{41}$; in other respects these examples accord in their structure with the details described above. Fragments of a high test, bearing the Survey-number G $\frac{302}{36}$, are remarkable for presenting in conjunction with that character a decided tendency to a subconoid form in the region of the apex, and in having a very distinct depression or wide trough-like encurvature along the median interradial areas on the abactinal surface, causing the test to appear somewhat melon-shaped. The tuberculation was probably less widely spaced than in the type forms of *Hipponoë antiqua*; but the fragments are unfortunately in a very bad state of preservation, and have been long exposed to the action of weathering. With more satisfactory material it may perhaps be found necessary ultimately to distinguish this form as a distinct variety, but for the present we abstain from giving it a name.

Remarks. This species is distinguished from *H. proavia* by the depressed and usually subconoid form of the test, by the narrow ambulacral areas, and by the widely spaced tuberculation of the interradial plates, and the consequently smaller number of tubercles on each plate.

Dimensions. The greatest diameter of the type specimen measures 127 millim., and the height is about 54 millim.; but the test has been so greatly crushed that little value can be placed upon the last measurement. A small example, which is only a little crushed, is 82 millim. in diameter and 46 millim. in height; whilst the fragment of another test, which does not appear to have been distorted, represents a test which we estimate at 95 millim. in diameter, and about 47 millim., or probably rather less, in height. A fragment of the high variety with interradial depressions measures 65 millim. in height, and belongs to a test rather more than 92 millim. in diameter.

Localities. In the Gáj series of strata:—

i. About three miles south-east of Tong. Survey-number G $\frac{302}{20}$.

ii. Scarp of the Mol Plateau, west of Kund (the same scarp as G $\frac{302}{17}$). Survey-number G $\frac{304}{14}$.

iii. Near the Habb River. Survey-number G $\frac{304}{10}$.

iv. Hill-scarp five miles north of Sháh Rhúi, on the Naig Nai, south-west of Jhangára. Survey-number G $\frac{302}{41}$.

v. Mol Plateau, fourteen miles north of Sháh-beg. Survey-number G $\frac{302}{36}$.

Illustrations of the Species in Plate XLIX.

Fig. 2. Abactinal view of the test: natural size.
3. Actinal view of a smaller specimen: natural size.
4. Profile view of the same fragment: natural size.

Genus ECHINUS (*Rondel.*), *Linné*, 1758.

1. Echinus subcrenatus, *Duncan & Sladen*. Plate XLIX, Figs. 5 & 6.

The test, which in its present state is considerably crushed, was probably much depressed, and with the marginal contour subpentagonal.

Ambulacral areas rather more than half the breadth of the interambulacral areas at the ambitus, where their proportion is about five ninths of the latter, as the ambulacral area measures 7·5 millim., and the interambulacral area 13·25 millim. at the ambitus, in the specimen under notice. The ambulacral areas contract gradually as they approach the apex. The poriferous zones are rather broad, with the pairs of pores disposed in regular oblique triplets, the obliquity decreasing as the apex is approached. The ambulacral plates are comparatively low and broad, their height at the ambitus being about one third of the width. Each is composed of three poriferous plates, the adoral and aboral ones being primaries, and the median a small wedge-formed demi plate, which does not quite reach the middle of the compound ambulacral plate; the suture which bounds the adoral poriferous plate passes slightly upwards from this point and obliquely, reaching the median ambulacral line near the middle of the aboral facet of the inner end of the ambulacral plate. The ambulacral plates bear one primary tubercle, placed close to the poriferous zone, and the series form a straight and regular vertical line on each side of the interporiferous area, extending from the apex to the peristome. The boss of the tubercle is of small elevation, but occupies nearly the whole of the depth of the plate, and is surrounded by a faint scrobicule. The mamelon is rather large and semiglobular, with scarcely any neck; it is imperforate and there is no crenulation. At the ambitus each plate bears a second tubercle nearly as large as that just described and precisely similar, placed near the inner end of the plate. Passing upwards towards the apex, these inner tubercles rapidly diminish in size, and cannot be traced much further than midway between the ambitus and the apex. Three or four tolerably large miliary granules, and frequently one or two irregular small ones, are present on the plates. One of the larger ones is usually placed near the aboral margin, and one on the adoral margin opposite the interspace between the two large tubercles above noticed; and frequently two small granules stand on the aboral margin over the inner large tubercle. A miliary tubercle is in association with the pore triplets, and is borne on the small median demi plate.

The interambulacral plates are wide and low, their height at the ambitus is one fourth of the breadth, the measurements being 1·75 millim. and 7 millim. respectively. The actual measurement of height remains constant up to the apex, but the breadth diminishes step by step on the abactinal surface until at the third coronal plate from the apex the breadth and the height are nearly the same, viz. 1·75 millim. The plates at the ambitus bear one primary tubercle, larger than the rest, and placed slightly on the outer side of the middle line of the plate; and this tubercle is the only one whose series forms a continuous vertical row extending from the apex to the peristome, the size being maintained throughout, and is a little larger than the primary tubercles on the ambulacral plates, but similar in character. On the inner side of this tubercle, on the plates at the ambitus, there are two other primary tubercles, that next to the large one first noticed being slightly smaller, and the one nearest the inner end of the plate still smaller. The small inner tubercle is not found on more than five or six plates above the ambitus, and the one next to the large tubercle does not extend to the apex, but is reduced to little more than a granule when it reaches the upper part of the area. On the outer side of the large primary tubercle are two moderate-sized secondary tubercles, placed vertically in relation to one another; and the series formed by these extend nearly to the apex. On the plates immediately at the ambitus there are frequently two similar, vertically placed, but smaller, tubercles, standing between the first-mentioned pair and the poriferous zone, and close to the latter; sometimes, however, there is only one. These small secondaries do not extend much above the ambitus, though a small granule, usually standing opposite the end of the adoral primary plate of an ambulacral plate, is so placed that it might be ranked in this series; but this is by no means regular in its occurrence, and does not extend much further than midway between the ambitus and the apex. A line of small mammillated granules, rather widely spaced, stands close to the aboral margin of the plate, indeed so close that frequently a part of the boss appears to be cut away, and a somewhat crenulate character is thus imparted to the margin of the plate. A few very minute miliary granules surround the scrobicule of the large primary tubercle, and a granule of irregular occurrence may stand opposite the interspaces between tubercles, near the adoral margin of the plate.

Apical disk and peristome unknown.

Remarks. At first sight this species suggests an affinity to the form we have named *Grammechinus regularis* from the Miocene of Kattywar[†], on account of the line of granules abutting on the aboral suture of the interradial plates, and appearing as if partially cut away. On closer observation, however, the tuberculation and the character of the two forms are generically different, and we see no reason for removing the species under notice from the genus *Echinus*.

Dimensions. The greatest diameter of our type specimen is 35 millim., but is somewhat affected by crushing; from the same cause it is impossible to give the true height of the test: in its present condition it measures about 17 millim.

Localities. In the Gáj series of strata:—

i. North of Babba band, five miles east of Kadeji. Survey-number G $\frac{302}{44}$.

ii. Scarp of the Mol Plateau, west of Kund (the same scarp as G $\frac{302}{17}$). Survey-number G $\frac{304}{14}$.

The specimen from the latter locality is a fragment in a very bad state of preservation and scarcely determinable; it is therefore referred to the species with doubt.

Illustrations of the Species in Plate XLIX.

Fig. 5. Abactinal view of the test: natural size.

6. Ambulacral and interambulacral plates a little above the ambitus: magnified.

[†] Tert. Foss. Echin. Kachh and Kattywar, p. 82, pl. xiii. figs. 7 & 8.

Order ECHINOIDEA EXOCYCLICA.

Suborder GNATHOSTOMATA.

Family CLYPEASTRIDÆ.

Subfamily EUCLYPEASTRINÆ.

Genus CLYPEASTER, *Lamarck*, 1801.

The types of MM. d'Archiac and Haime's *Clypeaster profundus* and *C. Halaenis*, which are preserved in the collection of the Geological Society of London, are worthless, weather-worn specimens upon which it is scarcely possible to base any critical determination. They are valueless in a case of specific comparison, and we shall therefore not attempt one in the present instance.

Amongst the great number of examples of *Clypeaster* obtained by the Survey from the Gáj strata in Sind, there is a large series which we consider to belong to one species, notwithstanding the excessive amount of variation occurring within its limits. The study of the recent species of *Clypeaster* has taught us how great the modification of external form in this group may be; and it is therefore not astonishing to find a similar plasticity of habit in the series of fossils referred to: although in the present instance it is carried to such a degree that scarcely two examples precisely alike could be selected from a series of over fifty specimens.

It is our opinion that the two species of d'Archiac and Haime referred to above, are both immature forms, which would take their place in the series under notice, if the types were good enough for comparison. On these grounds we propose to describe the mature, and what seems to us characteristic, form of the series in question under the name of *C. profundus*, solely from our wish to avoid multiplying names unnecessarily and our unwillingness to rob our illustrious predecessors of one link in the chain which binds their names to posterity.

1. CLYPEASTER PROFUNDUS (*d'Archiac*), *Duncan & Sladen*. Plate L, Figs. 1–4.

Marginal contour subpentagonal with the angles rounded, longer than broad in the proportion of 1 : 0·913. The greatest breadth is opposite the termination of the antero-lateral petals; the lateral sides are very faintly incurved as they contract towards the posterior end, whilst the margin of the odd posterior interradium is rather more decidedly incurved. At the margin the test is very thin, and more or less undulating in consequence of being slightly tumid in the prolongation of the radial areas; the abactinal surface passes from the margin with a very gentle slope at a small angle of declivity, until it reaches the extremity of the ambulacral petals, where it rises abruptly to form an arched dome of considerable elevation, which comprises the whole region of the petals. Seen in longitudinal profile, the posterior declivity of the dome is greater than the anterior, whilst the slope of the test from the dome to the margin is rather more rapid anteriorly than posteriorly.

The apical disk is subcentral, or very slightly excentric in front. The ambulacral petals are short, wide, petaloid, very full and widely rounded, almost closed at the outer extremity, and prominently tumid. The odd anterior ambulacrum is slightly the longest: and the antero-lateral pair are subequal to, or very slightly shorter than, the posterior pair. The greatest width of the paired petals is opposite to, or even a little beyond, the commencement of the outer third, and is proportional to the length as 5 : 8, the actual dimensions of the postero-lateral petal in the example under description being 24 millim. long, and its greatest breadth 15 millim. The poriferous zones are very wide on the outer part of the petal, their breadth increasing gradually from the apical extremity until within a few pairs of pores of the outer extremity, the latter diminishing rapidly. The conjugating furrow which unites the pores of a pair is faint and indistinct, and its position is very oblique in relation to the zone, the degree of obliquity increasing as the outer extremity is approached, until the outermost pairs of pores are nearly parallel with the median axis of the ambulacral area. The intervening costæ are low and rather narrow, and are ornamented with a row of 5 or 6 small primary tubercles widely and equidistantly spaced amongst the close granulation. The broadest part of the poriferous zone is 4 millim. and is wider than half the interporiferous area at that place. The widest part of the interporiferous area is nearer midway between the extremities and measures 7·5–8 millim. in the antero-lateral petals, and is a trifle broader in the posterior pair. The odd anterior petal is generally similar in detail to the paired petals just described, excepting that it is not so full, or rounded so abruptly, at the outer extremity. The distance of the paired petals from the margin is about equal to their own length.

The interradial areas are extremely narrow and band-like near the apex, on account of the expansion of the petals. The ornamentation of the interradia and interporiferous areas consists of very small primary scrobiculated tubercles, with the interspaces about equal to, or occasionally very slightly greater than, the diameter of the scrobicules, the interspaces being filled with small, but distinctly spaced and definitely semiglobular, uniform, miliary granules.

The actinal surface is concave, with the peristome deeply impressed; the concavity commencing very near to the margin and increasing gradually inwards, the surface lying between the peristome and the margin being individually gently convex. The ambulacra are in shallow widely-expanding grooves.

The periproct is small and perfectly circular, situated rather more than its own diameter away from the margin.

Remarks. This species is readily distinguished from any of the other Indian Clypeasters by the abruptly elevated dome-shaped region of the ambulacral petals. It is perhaps nearer to *C. Scillæ*, Desmoulins, from the Miocene of Corsica &c., than any other form, but is very different. In *C. profundus* the petals are shorter and further removed from the margin, the elevated abactinal dome more prominent and abrupt, the margin much thinner, with its contour less indented in the interradia; and finally the actinal surface is much more widely concave, and not plane with a sudden depression to the peristome as in *C. Scillæ*.

Variations. We have already remarked on the amount of variation that occurs within the limits of the large series of specimens which we regard as belonging to this species. The variation chiefly affects the marginal contour, the degree of convexity of the abactinal surface, and the character of the interporiferous area of the petals. The marginal contour is more definitely pentagonal and broader in some examples, more elongate and produced anteriorly and with a tendency to a suboval form in others; and the amount of interradial incurvature is likewise variable. The distinctness and the amount of elevation of the abactinal dome is much greater in some examples than in others, and this apparently irrespective of age. In others, again, the distinct character and abrupt rising of the "dome" is more or less merged in the general convexity of the abactinal area. The amount of tumidity of the interporiferous area of the ambulacral petals is also subject to variation, and appears to be proportionately less in small specimens. It may here be mentioned that there are about half a dozen medium-sized examples, the largest 72 millim. in length, from different localities, in which the interporiferous areas are comparatively narrow and in which the tumidity is almost, and in some cases quite, wanting. After carefully studying the material at our disposal, however, we do not feel warranted in removing these examples from the present species, as intermediate forms may easily be selected. We consider it probable that one of d'Archiac and Haime's forms would rank along with these just mentioned, whilst the figure of *C. profundus* given in the Anim. foss. de l'Inde (pl. xiv, fig. 1*a* and 1*b*) well represents the variety under notice. *C. Halaensis* is also an immature form in which the petaloid tumidity is developed; and it is only just to observe that MM. d'Archiac and Haime themselves appear to have had doubts (loc. cit. p. 208) as to the reality of the difference of this species from *C. profundus*. It should here be remarked that in quite young examples, 28–40 millim. in length, which we consider to belong to this species, the tumidity of the petals is rarely ever present, and then only in a very feeble degree; whilst from the general form, character, and occurrence of these small tests we have no hesitation in referring them to the series under notice.

Dimensions. Length of the test 92 millim., breadth 84 millim., height 24 millim.

Localities. In the Gáj series of strata:—

i. Myhír scarp, Habb valley. Survey-number G $\frac{204}{13}$.

ii. Scarp of the Mól Plateau, west of Kund (the same scarp as G $\frac{203}{17}$). Survey-number G $\frac{204}{14}$ †.

iii. Scarp at Kúpo-jo-lak, or pass on the Mól range, west of Sháh-beg (same locality as G $\frac{280}{42}$). Survey-number G $\frac{203}{17}$.

iv. Ten miles north of Sháh-beg. Survey-number G $\frac{202}{18}$.

v. About three miles south-east of Tóng. Survey-number G $\frac{202}{20}$.

vi. Four miles south-west of Beynír Hill. Survey-number G $\frac{202}{23}$.

vii. Scarp six miles south-east of Sháh-beg. Survey-number G $\frac{202}{24}$.

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† This specimen is marked G $\frac{202}{14}$; as no such Survey-number occurs in the list of Gáj specimens, it is probably an error of the marker, intended for G $\frac{204}{14}$.

viii. Upper portion of scarp four miles west of Trak Hill. Survey-number G $\frac{202}{38}$.

ix. Naig-Nai valley, twelve miles south of Sháh Rhúi. Survey-number G $\frac{202}{40}$.

x. Ravine on the south-east of Bill, twelve miles north of Sháh-beg (about 30 feet below the coral zone). Survey-number G $\frac{202}{43}$.

xi. A few miles south of Pír Mangal (Mugger Peer). Survey-number G $\frac{202}{51}$.

xii. Entering the hills on the road from Jangri to Búla Khán's Thána. Survey-number G $\frac{280}{28}$.

xiii. Eight miles south of Jangri, east side of the Súrjána range. Survey-number G $\frac{280}{39}$.

xiv. Hills east of Thăna Sháh-beg (nearing Páni gúmbök from the west). Survey-number G $\frac{280}{405}$.

xv. Six miles east-north-east of Karáchi. Survey-number G $\frac{226}{18}$ †.

xvi. Amra Hill, Bárri Nai, Shikápur district. Survey-number G $\frac{226}{46}$.

xvii. Pír Gáji, west of Sehwan. Survey-number G $\frac{226}{48}$ ‡.

xviii. Tandra Ráhim Khán, west of Sehwan. Survey-number G $\frac{226}{49}$.

xix. Nine miles north-west of the town of Karáchi. Survey-number G $\frac{226}{53}$ ‡.

Illustrations of the Species in Plate L.

Fig. 1. Abactinal view of the test: natural size.
2. Longitudinal profile of the same: natural size.
3. An ambulacral petal: magnified.
4. Ornamentation of the interradial plates on the abactinal surface: magnified.

2. **Clypeaster pulvinatus**, *Duncan & Sladen.* Plate L, Figs. 5 & 6.

Marginal contour elongately subpentagonal, with the angles tumid and rounded, and the intervening areas more or less incurved. The length is proportional to the breadth as 1 : 0·773, and the breadth opposite the extremities of the anterior pair of petals is about equal to that opposite the extremities of the posterior pair. The lateral sides are distinctly incurved, and also the posterior margin, but to a less degree. The anterior margin has a rather arched or produced appearance, converging as it proceeds forwards, and the incurving of the anterior interradia is scarcely perceptible. The margins are very thick and tumid, especially in the radial regions. The abactinal surface is subdepressed, but is slightly convex in the region of the petals, and the latter have also a more or less tumid tendency. In the interradia, at a little distance from the margin, there is a slight concavity which emphasizes the tumidity of the margin as well as the convexity of the central area. Seen in longitudinal profile the anterior slope is much less rapid than the posterior, and the anterior margin is also much thicker.

The apical disk is subcentral. The ambulacral petals are long and broad, lanceolate, rather widely open at the outer extremity. The odd anterior petal and the posterior pair are nearly equal in length, and the anterior pair are slightly shorter.

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† A very young example, nearly hidden in matrix, which may not belong to this species.

‡ A single specimen in bad condition and more or less doubtful.

The greatest width of the petals is about midway between the extremities, and is proportional to the length as 1 : 1·85, the actual dimensions of the postero-lateral petal in the example described being 25 millim. long and 13·5 millim. broad. The poriferous zones are very wide outwardly, and their breadth increases step by step until within eight to ten pairs of pores from the extremity; it then very gradually diminishes until the last one or two pairs of pores, which diminish rapidly and give a somewhat rounded character to the termination of the poriferous zone. The inner pores are round and the outer pores only very slightly oval or subpyriform near the outer extremity of the petal; they are united by an indistinct and shallow conjugating furrow, and the intermediate costæ are ornamented with five or six small scrobiculated tubercles, closely placed and often with a little irregularity in their disposition. The broadest part of the poriferous zone is 3·5 millim. and is equal to half the breadth of the interporiferous area at that place. The widest part of the interporiferous area is nearer the apex than midway between the extremities, and measures 9 millim. or a fraction less. The odd anterior ambulacrum is similar in all respects to those above described, the length being a little greater, and the poriferous zones perhaps not attaining quite so great a breadth. The distance of the paired petals from the margin is greater than half their length, but in the case of the odd anterior petal the distance is greater.

The interradial areas are very narrow and insignificant on quite the inner half of the abactinal area. On the outer portion their ornamentation consists of small scrobiculated tubercles, with the granular interspaces between the scrobicules on the average not greater than the diameter of the scrobicules. At the margin and on the actinal surface the scrobicules are closely placed and only separated by a narrow dissepiment. On the interporiferous areas the scrobicules are usually separated by spaces less than their own diameter in width.

The actinal surface is concave, the depression commencing at a little distance from the tumidity which is found surrounding the margin, and continues to the mouth without curvature. The ambulacra on the actinal surface are in rather deep well-defined grooves.

The peristome is small and subcentral; the periproct small, circular, and not more than its own diameter distant from the margin.

Remarks. In general appearance this species looks like a gigantic *C. scutiformis*, but is distinguished from that form by its more pentagonal marginal contour, by the different form of the petals, as well as by its size.

Dimensions. Length of the test 84 millim., breadth 65 millim., height 18 millim.

Locality. In the Gáj series of strata: Ravine on the south-east of B 11, twelve miles north of Sháh-beg (about 30 feet below the coral zone). Survey-number G $\frac{202}{431}$.

Illustrations of the Species in Plate L.

Fig. 5. Abactinal view of the test: natural size.
6. Longitudinal profile of the same: natural size.

3. CLYPEASTER PELVIFORMIS, *Duncan & Sladen*. Plate L, Figs. 7–9.

Marginal contour suboval, or with a slight pentagonal tendency in large specimens. The posterior angles and the posterior margin are rather flatly truncate, whilst the remainder of the contour is well rounded. The length is greater than the breadth in the proportion of 1 : 0·9, and the greatest breadth is opposite the termination of the antero-lateral petals. The general form is low and subdepressed, but the margins are thick and tumidly rounded; and the abactinal surface rises from thence to the apex, forming a slightly conical convexity of low elevation and with gentle declivities.

The apical disk is central. The ambulacral petals are moderately long and wide, petaloid, suboval in contour, and rather widely open at the outer extremity. There is a slight depression in the interradial areas, which gives a faint suggestion of tumidity to the petals; although strictly these cannot be described as tumid. The odd anterior petal and the postero-lateral pair are subequal in length, and the antero-lateral pair are slightly shorter. The greatest width of the paired petals is about midway between the apex and the extremities, and is proportional to the length as 11 : 20, the actual dimensions of the postero-lateral petal in the type specimen being 20 millim. long and its greatest breadth 11 millim. The poriferous zones are very wide, and the breadth increases continuously from the apex up to within 9 or 10 pairs of pores from the extremity; 5 or 6 pairs of pores are then of uniform width, and the zone is terminated by only 3 or 4 much narrower; there is also sometimes a little group of 3–4 sporadic spores immediately at the termination of one of the zones. The inner pores are round, and the outer ones slightly larger and transversely oval, their elongation being greatest on the outer part of the zone. The pores of a pair are united by a distinct conjugating furrow, the intermediate costæ are rather broad, and their ornamentation consists of two or three widely-spaced scrobiculate tubercles with granules between. The broadest part of the poriferous zone is 3·5 millim., and is nearly two thirds of the width of the interporiferous area at that place. The widest part of the interporiferous area is about midway between the extremities, or perhaps slightly more outward, where it measures 6 millim. The odd anterior petal is similar in all respects to the paired petals above described, but is perhaps a shade narrower. The distance of the petals from the margin is subequal, and is approximately about half the length of the petal, although it appears much less on account of the rounding of the margin.

The interradial areas are very contracted on the inner half of the abactinal surface, the length of the eight uppermost plates in each column being greater than their breadth. The ornamentation consists of small scrobiculate tubercles which are much more widely spaced than usual, the feature being at once conspicuous. Very frequently the granular interspaces are twice the width of the diameter of the scrobicules and sometimes more; the scrobicules are less regular in their spacing, and have somewhat of a sporadic disposition. The scrobicules of the interporiferous areas are more closely placed than in the interradial areas, but are less numerous than usual.

The actinal surface is deeply concave and widely basin-formed; the concavity occupying nearly the whole of the actinal surface, its margin being round and tumid and confluent with the margin of the test. The ambulacral grooves are feebly defined and do not extend to the margin.

The peristome is unknown. The periproct is very small, and its distance from the margin is nearly twice its own diameter.

Remarks. This species is readily distinguished from its congeners by the broad petaloid ambulacra, by the slightly-convex abactinal surface, the thick and tumid margins, the deep and widely-concave actinal surface, and the widely-spaced scrobiculate tubercles.

Dimensions. Length 61 millim., breadth 55 millim., height 17–18 millim. The large example drawn in Fig. 9 is imperfect in length and height; its greatest breadth is 65 millim.

Locality. In the Gáj series of strata: A few miles south of Pír Mangal (Mugger Peer). Survey-number G $\frac{302}{51}$.

Illustrations of the Species in Plate L.

Fig. 7. Abactinal view of a small test: natural size.
8. Longitudinal profile of the same: natural size.
9. Actinal view of a larger test: natural size.

4. Clypeaster complanatus, *Duncan & Sladen.* Plate L, Figs. 10 & 11.

Marginal contour subpentagonal, with the three anterior angles confluently rounded so as to form an arched or almost semicircular anterior margin; whilst the posterior angles are rather flatly truncate in their rounding. The length is greater than the breadth in the proportion of 1 : 0·911, and the greatest breadth is opposite the extremity of the antero-lateral petals; the lateral sides are straight and converge as they proceed backwards; the posterior extremity is not incurved but nearly straight, faintly undulating on account of a slight convexity in the median interradial line, on either side of which there is a very slight concavity. The general form is flat and depressed, with the margins thin, and the abactinal surface sloping from the very slightly elevated apex at a low angle of declivity, the lines of slope as seen in profile being almost straight, and the apex is consequently feebly conical or peak-like.

The apical disk is central. The ambulacral petals are moderately long and wide, petaloid, with a comparatively straight appearance, in consequence of their length and the rather abrupt rounding at the outer extremity; the zones do not close, and the areas of the petals are not tumid. The paired petals are subequal in length, and the odd anterior petal is a little longer. The greatest width of the paired petals is about midway between the extremities and is proportional to the length as 19 : 44, the actual dimensions of the postero-lateral petal in the example under notice being 22 millim. long and its greatest breadth 9·5 millim. The poriferous zones are very wide and the breadth increases up to within 7 or 8 pairs of pores from the extremity, when it diminishes to form the rounding of the petal, and the posture of the pairs of pores in relation to the zone becomes at the same time more oblique. The inner pores are round and the outer much larger and pyriform, and the pairs are united by a very faint conjugating furrow. The costæ intervening between successive pairs are low and rather narrow, and are ornamented with three small and well-spaced scrobiculated tubercles, which do not come upon the part that separates the large outer pores, where the costa is very narrow. The broadest part of the poriferous zone is 3 millim., and is very nearly as wide as the interporiferous area at that place. The widest part of the interporiferous area is midway between the extremities, where it measures 4·25 millim. The odd anterior petal is similar in all respects to the paired petals above described, except that its outer extremity is rather fuller and more abruptly rounded. The distance of the anterior pair of petals from the margin is rather less than two thirds of their length, and the distance of the posterior pair is rather greater.

The interradial areas are very faintly tumid or subcarinate on the inner half of the abactinal surface. Their ornamentation consists of very small primary scrobiculated tubercles, the intermediate spaces, which are covered with small uniform granules, being usually rather greater than the diameter of the scrobicules. The ornamentation of the interporiferous area is similar, but the scrobicules are more numerous and more closely placed, and there is a general tendency to confluence in the intermediate granulation.

The actinal surface is perfectly plane, being abruptly rounded but not impressed at the peristome, which is small, circular, and subcentral. The ambulacra are in rather deep well-defined grooves, which extend nearly to the margin.

The periproct is small and circular, and its distance from the margin is less than its own diameter.

Remarks. This species is distinct from its congeners and other Indian forms by its great depression, by its marginal contour, by the form of its petals, and by the flat and unimpressed actinal surface. It comes nearer, perhaps, to *C. placunarius* (Lam.), Agassiz (*C. humile*, Klein, pars), than to any other form, but is much more depressed, and with the abactinal surface more conical and pointed at the apex, with the margin more uniformly rounded and with no reentering curvatures, and with the petals more widely open at the extremity.

Dimensions. Length of the test 79 millim., breadth 72 millim., height 13 millim.

Localities. In the Gáj series of strata:—

i. Scarp of the Mól Plateau, west of Kund (the same scarp as $G\,\frac{402}{17}$). Survey-number $G\,\frac{304}{14}$.

ii. Scarp at Kúpo-jo-lak, or pass on the Mól range, west of Sháh-beg (same locality as $G\,\frac{280}{42}$). Survey-number $G\,\frac{302}{17}$.

iii. Four miles west of Beynír Hill. Survey-number $G\,\frac{302}{23}$.

iv. Gandak Hill, near Thado. Survey-number $G\,\frac{302}{45}$.

v. Hill near Giaibi, on the Báran River, south-east of Tóng. Survey-number $G\,\frac{226}{37}$.

Illustrations of the Species in Plate L.

Fig. 10. Abactinal view of the test: natural size.
11. Actinal view of the same: natural size.

5. **Clypeaster depressus**, *Sowerby*.

This species was described by Sowerby in Grant, Trans. Geol. Soc. ser. 2, vol. v. pt. 2, and we noticed it in the description of 'The Fossil Echinoidea of Kachh" in 1883, p. 58. It is a common Miocene form in Kachh, and there is a well-marked specimen in the Gáj deposits. We do not figure the form, as the drawing on Plate X, Figs. 5–9, in the Kachh Echinoidea will suffice.

Locality. Gáj series or Miocene of Sind: About three miles south-east of Tóng. Survey-number G $\frac{309}{20}$.

Family SCUTELLIDÆ.

The test is reduced to its extreme flatness among the Clypeastroids; the outline is more or less circular and is frequently cut at the margin or perforated, so as to form ambulacral cuts or lunules. The ambulacral furrows on the actinal side are more or less branching and anastomose, spreading over to the interradial spaces. Connection between the upper and lower floors of the test is by radiating fan-shaped partitions, coming from single points. The tubercles of the upper and lower surfaces of the test as well as the spines which they carry differ much in size. The rotulæ of the dental apparatus are absent and the auricles are low. The teeth are more or less horizontal.

Genus ECHINODISCUS, *Breyn.*, amended *A. Agassiz*, 1872.

This genus was established by Breynius in 1732, but A. Agassiz so modified the scope of it in his 'Revision' that it is no longer correct to add the name of the original founder to a description which differs considerably from that which he gave. As we have already stated in our Monograph of the Tertiary Echinoidea of Kachh and Kattywar ('Palæontologia Indica'), the genus as now defined contains the genera *Lobophora* and *Amphiope*. It is one of the family of the Scutellidæ, Agassiz, amended by his son in the revision of the genera, 1872–74.

The following are the essential points in the diagnosis of the genus according to A. Agassiz (Revision, &c. p. 531):—

The test is more depressed than in the other Scutellidæ and is thin; anterior edge rounded, posterior truncated. There are two lunules, or cuts, corresponding to the posterior ambulacra. Ambulacral petals small and well limited. Four genital pores. Lower surface flat, and the furrows ramify but little towards the exterior edge. Anus nearer the posterior edge than to the peristome. The greater part of the test is occupied by a calcareous network rising into pillars for more than half the distance between the edge and the peristome, internally leaving the central part more or less covered by a delicate tracery of limestone cells into which the appendages of the alimentary canal are received. No pillars or partitions separate the buccal cavity from the alimentary canal.

1. **Echinodiscus Desori**, *Duncan & Sladen*, 1883. Plate LI, Figs. 1 & 2.

This species was described in the Monograph of the Tertiary Echinoidea of Kachh and Kattywar (Pal. Indica, Ser. XIV. p. 60, 1883), and was figured on plate xii. of that work.

This Miocene species is not common in the Gáj deposits, and there are some forms which we cannot but consider as the adults of the species with some variation in their shape.

In the type from Kachh the anterior petal is longer and narrower than the antero-lateral, the two lunules are elliptical in outline and they are narrow, the long diameter being not quite three times the breadth. The anterior margin is faintly indented and the test is broadest on a line with the distal ends of the posterior ambulacra. The breadth of the test is greater than the length, and there is a decided narrowing in front and a broadening out behind. The actinal grooves are broad and shallow; they bifurcate near the mouth-curve symmetrically, and enclose rather long spaces. Each groove has a raised ridge on its floor near the peristome, which ends in a slight swelling perforated by two tentacular pores.

A small specimen from the Gáj deposits is figured on Plate LI, Fig. 1, and an outline is given, Fig. 2, of a small form. In both the convexity of the test posteriorly is shown, and it will be observed that there is some difference in the dimensions of the lunules. The length and the breadth of the form represented by Fig. 1 are equal, but the breadth of the form of Fig. 2 is normal, and the breadth is greater than the length. The figures are natural size, and the specimens came from the Miocene or Gáj deposits of Sind.

Locality. Four miles south-west of Beynír Hill. Survey-number G $\frac{301}{21}$.

Illustrations of the Species in Plate LI.

Fig. 1. The abactinal view of a test: natural size.
2. Outline of a test: natural size.

There is a well-marked variety of the species which we have drawn on Plate LI, Fig. 3. The test is slightly broader than the type, the petals are subequal, and the posterior edge of the test is almost straight. The general shape of the type is not much altered, the lunules are of the same shape and the test is of the same great tenuity. The variety brings the type in close alliance with *Echinodiscus biforis*, A. Agass., a recent form from the Red Sea and East-African coast.

Illustrations of the variety in Plate LI.

Fig. 3. The test: natural size.

Echinodiscus Desori, *Duncan & Sladen*, variety. Plate LI, Figs. 4, 5, 6, 8, 9, 12.

This variety has all the characters of the species, and the test is also nipped in anteriorly to the widest part, so as to give more or less of a trifoliate appearance.

Locality. Gáj series or Miocene of Sind: Hills E. of Thána Sháh-beg. Survey number G $\frac{280}{40}$.

Illustrations of the Species (variety) in Plate LI.

Fig. 4. Actinal surface: natural size.
5. Abactinal view: natural size.
6. A lunule seen from the actinal side: magnified.
8. A view of the crushed jaws and supporting internal structures.
9. Another view: slightly magnified.
12. A view of a side of a broken piece of the test of a large form, showing the sides of the supporting plate and a few pillars.

2. Echinodiscus, sp.

A much mutilated pair of specimens of considerable dimensions are to be seen in the collection from the Gáj deposits. One of the specimens has a part of two small oval lunules, each of which was, when perfect, about one half of the size of a petal.

The test is broader than long, rounded and slightly notched in front, broadest behind the antero-lateral petals, and with a very low and depressed test, there being hardly any rise from the excessively thin edge to the apical system. The anterior petal is the longest, and the apical system is large. The four generative pores are beyond the basal plates. Actinally the test is nearly flat, but no details can be made out. On the whole the resemblance is to *Echinodiscus Desori*, but the lunules differ in shape. The breadth of the test was nearly 90 millim. and the length was less.

Locality. Gáj series or Miocene of Sind: Four miles S.W. of Beynír Hill, and three miles S.E. of Tong. Survey-number G $\frac{302}{23}$ and G $\frac{301}{20}$.

3. Echinodiscus placenta, *Duncan & Sladen.* Plate LI. Fig. 7, Plate LII, Figs. 1–3, 8.

The test is broadly ovoid, broadest behind on a level with the end of the apical one third of the posterior ambulacra, nearly semicircular behind, and narrowing gradually in front so as to be bluntly pointed anteriorly where there is a shallow incurvation. The length is 91 millim., and the breadth is 85 millim. The test has very sharp margins, a flat actinal surface, and the height is exceedingly small for the size, being at the most 8 millim.

The apical system is large and slightly excentric in front; the generative pores are beyond the basal plates and the optic pores are indistinct. The madreporite is central. The anterior petal is the longest and, like the others, is not quite closed. The rosette is about the length of a petal from the side of the test, and the posterior petals are at a greater distance, there being a lunule in a line with each towards the margin. There is much surface between the petals and the margin of the test. The lunules are two in number, one in each posterior ambulacral space. They are large and 11 millim. in length and 7 millim. in breadth. They are therefore broadly elliptical in shape and are about half their length from the posterior margin. The amount of interradial space is considerable, and there is only the slightest rise from the margin of a space to the apical system. The plates of the ambulacral petals are very numerous, the inner pores are in broad ellipses, the outer are long and narrow. But the plates of the interradia are large and have a remarkable contour near the apical system. The adoral and aboral edges of the coronal plates are not transverse to the median interradial line, but oblique, and they are not straight, but are in curves, with the convexity adorally; moreover the median sutural lines are in bold curves, so that the appearance of the plates is that of imbricating scales. There was, however, no overlap. See Fig. 7 on Plate LI.

Unfortunately the under surface of the test is eroded. The internal structure of the test is indicated on the worn upper surface, where the peculiar markings so characteristic of the genus are well seen.

Locality. Gáj series or Miocene of Sind: Naig-Nai valley, twelve miles S. of Sháh Rhúi. Survey number G $\frac{302}{40}$.

Illustrations of the Species in Plates LI and LII.

Plate LI.

Fig. 7. Portion of an interradium and of ambulacra: slightly magnified.

Plate LII.

Fig. 1. The test: natural size.
2. Apical system: magnified.
3. Part of an ambulacrum: magnified.
8. A portion of an ambulacrum and lunule: slightly magnified.

The shape of this species is very characteristic, and its great expansion and very depressed form are extreme in the genus.

The lunules are very broad and the form is unlike any recent kind.

The next two species of *Echinodiscus* belong to quite a different series, for they are either almost circular or ovoid in shape, with the greatest width in front.

4. Echinodiscus ellipticus, *Duncan & Sladen.* Plate LI, Fig. 11.

The test is exceedingly flat, nearly circular, being 68 millim. in length and 66 millim. in breadth. The apical system is only very slightly excentric in front and is sub-central. The petals are subequal, rather narrow, and are very slightly swollen. The rosette occupies 38 millim. of the 66 millim. of the breadth.

There are two lunules and they are long elliptical in shape.

The anterior margin of the very thin test is slightly incurved and the posterior appears to have been rounded off.

Locality. Gáj series or Miocene of Sind: Scarp of the Mól Plateau, W. of Kund. Survey-number G $\frac{304}{14}$.

Illustration of the Species in Plate LI.

Fig. 11. The test: natural size.

5. ECHINODISCUS ELONGATUS, *Duncan & Sladen*. Plate LI, Fig. 10.

The test is very low, thin, longer than broad, more sharply rounded at the anterior margin than at the posterior, where it is nearly straight and broadest in front of the antero-lateral petals.

Apical system slightly excentric in front, system large, hexagonal, and the generative pores at the angles and beyond them. The ambulacra are subequal, broad, and the posterior pair are close together at the apex. Poriferous zones nearly closed, and the interporiferous areas are well developed. The ends of the lateral ambulacra are not quite their own length from the margin of the test, and the rosette is small. There is a long narrow lunule in each posterior ambulacral tract, and the length is nearly that of the petal, from which it is only separated by a very short distance.

The interradia are large and their plates have the same adoral curving and median curving also which have been noticed in the instance of *Echinodiscus placenta*, nobis, and figured on Plate LI, Fig. 7. The length of the specimen is 47 millim., and the breadth 40 millim.

Locality. The Gáj series or Miocene of Sind: Naig-Nai valley, twelve miles S. of Sháh Rhúi. Survey-number G $\frac{302}{40}$.

Illustrations of the Species in Plate LI.

Fig. 10. The test in outline: natural size.

6. ECHINODISCUS, sp. Plate LII, Figs. 4–7.

A large form, the details of which are not sufficiently preserved to enable a specific diagnosis to be made, is in the collection from four miles S.W. of Beynír Hill. Survey-number G $\frac{302}{23}$.

The distinctive character is the slight dome shape and the evident slight hollowing out of the well-marked actinal surface. The edge, however, is thin. The apical disk is large, and one of the subequal petals is 27 millim. long. The lunules are not preserved.

Illustrations of the form in Plate LII.

Fig. 4. The abactinal view: natural size.
5. Actinal view.
6. A part of the abactinal surface: magnified.
7. Surface of a test, showing the tops of the supporting structures.

A fragment in the collection leads to the inference that there are some very large forms of *Echinodiscus* in the Miocene of Sind, for the petal of one is 35 millim. in length and 14 millim. in breadth.

Suborder ATELOSTOMATA.

Family CASSIDULIDÆ.

Subfamily ECHINOLAMPINÆ.

Genus ECHINOLAMPAS, *Gray*, 1825.

1. Echinolampas Jacquemonti, *d'Archiac & Haime.* Plate LIII, Figs. 1–14.

Test of moderate size. Marginal contour subovoid, well rounded in front and sometimes rather flattened, the sides expanding gradually with a gentle curve up to the posterior part of the lateral interradia, where the greatest breadth is situated, and the margin then contracts with comparative rapidity to form a more or less distinctly rostrate posterior extremity. The breadth is rather more than four fifths of the length (82–85 per cent.), the disparity being usually less in smaller examples. The apical disk, which is excentric in front and corresponds with the apical summit of the test, is distant from the anterior extremity a little less than two fifths of the length. The height of the abactinal surface shows considerable variation, ranging from rather more than two fifths to rather more than one half the length. Seen in longitudinal profile, the abactinal outline presents in some forms a rather flat convexity, whilst in others there is a more or less conspicuous tendency towards a conoid elevation in the region of the apex, the posterior slope in either case being gentle until it takes a well-rounded, or rather rapid, curve over the posterior rostration; the anterior slope is more rapid, and the margin is high and tumid. The lateral margins are thick, tumid, and well rounded on to the actinal surface, which also has a tumid character in consequence of the slight but distinct depression around the peristome.

The apical disk is small, and there are four genital pores, which are of comparatively large size and occupy nearly the whole of their plate; the anterior pair are rather closer together than the posterior pair. The ocular plates are small and elongate transversely, and their pores are very minute; the posterior are distinctly nearer together than the anterior pair, and are separated by a more or less definite extension of the central madreporic plate, which is, however, more distinctly prolonged in some examples than in others. The whole of the central portion is occupied by the madreporiform body, the punctures of which are very small and numerous; the surface is often distinctly convex, and minute miliary granules are distributed irregularly over it.

The ambulacral petals are comparatively small, and though narrow, are very definitely petaloid, expanding rather rapidly for a short distance from the apex and then gradually contracting, the width of the interporiferous area at the extremity being little greater than half the width at the widest part of the petal, and in some instances less than this. The posterior petals are the longest, and the odd anterior is the shortest; the breadth of the lateral petals is about equal (6 millim.), and the odd anterior petal is slightly narrower. The breadth of one of the paired petals is in the proportion of about $\frac{102}{1000}$ of the length of the test. The poriferous zones are unequal; the anterior zones of the antero-lateral petals and the posterior zones of the postero-lateral petals being shorter than the companion zone of the same petal. The breadth of the poriferous zone, excepting the narrow apical extremity, varies only slightly throughout the major portion of its length, the decrease towards the outer extremity being slight. At the widest part of the petal, the width of the poriferous zone is rather less than one third of the width of the interporiferous area, the actual breadth of the poriferous zone being only 1·125 millim. in an example 55 millim. in length, but is often less. The inner pores of a zone are round, and the outer ones slightly elongate or pyriform, the pair being united by a well-developed channel; and the posture of the pairs of pores is very oblique in relation to the zone. The divisional costa between each pair is ornamented with a single line of small miliary granules. Near the extremity of the anterior zone of the antero-lateral petals the zone is distinctly and rather suddenly incurved (concavity forwards), which gives a slightly sigmoid character to the zone, especially in comparison with the regularly arched and longer companion zone in the same petal. The extra-petalous continuation of the poriferous zones is scarcely visible to superficial observation until midway on the actinal surface, between the margin and the peristome; although in some favourable examples the course of the zones of the odd anterior petal are more or less faintly defined throughout by slight channelling. When the poriferous zones reach the neighbourhood of the peristome they are sensibly channelled, the pores are distinct, and well-developed sublyriform phyllodes are produced. A regular internal series of pores, one pore opposite alternate pores of the outer series with more or less regularity, is present; and a double series of pits (presumably for sphæridiæ) are situated in the median radial line of the phyllode. The interporiferous areas may almost be said to be flush with the test, although in some cases those within the petals of the paired ambulacra are very faintly tumid. The ornamentation of the areas both within and without the petals is similar to that of the interradial areas.

The lateral interradial areas are the broadest, and their breadth is nearly equal to the whole area included by the antero-lateral ambulacra, *i. e.* to the two anterior interradia and the odd anterior ambulacrum combined. The anterior interradia are by far the smallest. In the odd posterior interradium there is considerable tumidity abactinally, over and conformable with the posterior rostration; and there is also considerable tumidity on this area on the actinal surface along the median line between the peristome and the periproct, the swelling expanding and gradually dying out as it approaches the latter aperture and the posterior margin of the test. There is considerable tumidity in the posterior column of the postero-lateral interradia, which conspicuously affects the marginal contour, and constitutes one of the features that contributes largely to the characteristic form of this species. The ornamentation of the interradial and interporiferous areas is uniform and small, and consists of small primary tubercles, sunken in rather deep, narrow scrobicules, the intermediate spaces being about equal to half the diameter of the scrobicule, and having the surface covered with small, distinct, and not particularly crowded miliary granules. On the abactinal surface, in well-preserved specimens, a distinct ring of granules encircles each scrobicule; there are thus two rings of granules in each intermediate space between scrobicules, and a few extra at the angles where four come together. At the ambitus the tubercles are more crowded and the intermediate spaces much narrower; on the median portion of the actinal surface, and round the peristome, the tubercles are more widely spaced and the scrobicules slightly larger.

The peristome is rather large, distinctly pentagonal, with the transverse diameter rather greater than the longitudinal. In small specimens the disparity of these dimensions is greater than in fully grown tests. The ambulacral areas are slightly sunken as they approach the peristome, and the bourrelets are well defined, especially the anterior pair. This pair presents a distinctly convex margin into the peristome. The posterior pair of bourrelets are the smallest, and their margins have a well-defined thickening; the odd posterior is the broadest and is the least tumid, though its margin is distinctly thickened. The peristomial wall is vertical and high, and its surface is covered with well-spaced small miliary granules, and these are also extended over the tumid portions of the bourrelets. The peristomial margins of the ambulacral areas form small and graceful concavities in the general peristomial margin, constituting the rounded angles in the outline of this orifice. The innermost pair of ambulacral pores (buccal pores) are well defined, and are situated immediately over the margin, opening into the peristomial wall. The phyllodes are well developed and have been described above.

The periproct is small, transverse, with an outline varying between suboval and subtriangular, placed close to the margin on the slight rounding which unites the actinal surface with the ambitus, and immediately below the posterior rostration. Consequent on this slightly oblique position (in relation to the plane of the actinal surface), the presence of the orifice is discernible when the posterior part of the test is placed on a resting plane held in the direct line of view, with the posterior extremity towards the observer. This aperture has a major diameter of 6·5 millim., and a minor diameter of 4 millim. in a specimen 55 millim. in length. The major diameter of the peristome is 5 millim., and the minor 3·75 millim., in a specimen of the same size.

Young forms. Although this species is a very variable one, certain marked features may be clearly traced throughout a wide range of different growth-stages; the modifications dependent on age, however, are at the same time striking and noteworthy.

In tests measuring 38–40 millim. in length (Figs. 8–10) it will be noticed that the marginal outline is more circular, that the breadth is greater, that the margins are more tumid, and that the abactinal surface is more regularly convex, than in the larger forms above described. It will also be seen that the test is fuller and more rounded in front, less rostrate posteriorly, and that the prominent tumidity in the posterior column of the postero-lateral interradia though present is much less developed; in a rather smaller test (Fig. 13), this tumidity is moved forwards to some extent, and thus produces, in conjunction with the other test modifications, a marginal contour approaching very nearly to a circular form. In examples of this size, the actinal surface is either subplane and gradually sloping off to the very tumid margins, or even faintly convex, excepting a feeble central depression around the peristome, and this concavity is perhaps not always present. Indeed there appears, without question, to be considerable diversity in this particular in different specimens of the same size. The smallest specimens which we unhesitatingly refer to *E. Jacquemonti* are from 22–27 millim. in length; there are, however, in the collection three or four other specimens, smaller than this, from as many different localities, and these we are strongly inclined to consider also as young forms of *E. Jacquemonti*. These small tests are remarkable for the great tumidity of the actinal area, the profile contour of which is almost as fully convex as that of the abactinal area, and in some of them at least there is no depression around the peristome. This aperture is comparatively small, and the periproct is higher in the margin in some of them than usual in the adult forms; but there appears more or less variation in the position of the periproct even amongst the small forms. These characters are such as might well be regarded as youthful features, and in other respects the tests do not differ more from the type form of *E. Jacquemonti* than our knowledge of the growth-stages of recent species of *Echinolampas* leads us to regard as perfectly consistent with the view that they are immature specimens.

There is, however, an example measuring 32 millim. in length, which presents all these extreme characters to the fullest extent; and this form appears to accord in every respect with the species named *E. spheroidalis* by d'Archiac and Haime; although in our opinion it is not improbable that with a larger range of small forms and in a better state of preservation than those we possess, *E. spheroidalis* may ultimately be found to be in reality only the immature stage of *E. Jacquemonti*. From the fact that our largest *spheroidalis*-like specimen (32 millim.) presents the above-mentioned well-marked features—youthful though they appear—at a size much greater than that at which the young *E. Jacquemonti* already exhibit their own specific and unmistakable habitus, we refrain for the present from interfering with the specific independence of *E. spheroidalis*, and rank the small specimens under notice provisionally and with doubt under that designation.

Variations. This species is remarkable for its variability within certain limits; and very numerous modifications of form are to be found in the collection under notice. These chiefly affect the relative proportions of length and breadth, the outline of the abactinal profile, the marginal contour to some extent, and also the breadth of the ambulacral petals. Considerable though these variations appear when extreme examples are compared, the intermediate stages are so numerous and unmistakable that we do not think it necessary or desirable to give names to these varieties; and this the more as the different changes above indicated may be found in a series of specimens from one and the same locality, and apparently of similar size, age, and fossilization.

Some forms are more elongate and distinctly ovate in marginal outline than others, as given in Figs. 1 and 2. Others, again, have the anterior margin fuller and flatter, as in Figs. 3–5; and this, in some rare cases, is carried to such an extent that the anterior margin has quite a truncate appearance, and the antero-lateral interradia present a considerably tumid angularity. In other tests, again, the margin is more orbicular (see Fig. 6). Considerable variation exists as to the degree of the tumidity developed in the posterior column of the postero-lateral interradia, and also as to the prominence of the posterior rostration. Another feature subject to much variation, and which at the same time produces a very striking series of modifications, is the relative height of the abactinal surface and the contour of the same as seen in longitudinal profile. In some forms the abactinal surface is comparatively depressed and its profile exhibits a more or less uniform and regular convexity, and often even slightly flattened centrally (see Figs. 1 and 2). Others, again, have a much greater relative height, and the abactinal surface shows a distinct and conspicuous conoid elevation in the region of the apex, with the anterior slope rapid, and the posterior more gradual and flexuous as seen in profile (compare Figs. 3–5). The breadth of the ambulacral petals is likewise subject to variation, and quite a number of examples with remarkably broad petals, when compared with the normal form, may be distinguished; and furthermore it is of interest to remark that the feature appears generally to be associated with the more or less subdepressed orbicular forms. An example of this variety is represented in Fig. 6. In this specimen the width of the paired ambulacra is $\frac{122}{1000}$ of the length of the test.

Remarks. This species is closely allied to the form we have named *E. Indica,* from the Miocene of Kachh. Both are very variable forms, and it would be quite possible to select a series which would appear to form a transition between the two species. Taken as a whole, however, the habit of *E. Indica* and *E. Jacquemonti* is different, and immediately strikes the eye. In the former the test is habitually higher, more regularly convex abactinally, and more tumid laterally. The inequality of the poriferous zones and the amount of their curvature is greater. The excentricity of the apical disk is less, the proportions of the peristomial and periproctal apertures, as well as their form, are different. On these grounds we consider the species distinct, but probably phylogenetically allied.

Dimensions.

	Breadth		Height	
Length in millim.	in millim.	proportion to length = 1.	in millim.	proportion to length = 1.
55	46	0·836	24	0·436
51	43	0·843	28	0·550
42	37·5	0·892	19	0·452
39	35·5	0·910	22	0·564
37	34	0·918	21·5	0·581
37	36	0·973	25	0·675
29	25·5	0·879	18	0·620
27·5	24·5	0·890	16	0·581

The largest example in the collection measures 72 millim. in length, and another 62 millim.; but both specimens are too much crushed for the other dimensions to be given with any degree of accuracy.

Localities. In the Gáj series of strata:—

i. Scarp of the Mól Plateau, west of Kund (the same scarp as G $\frac{304}{17}$). Survey-number G $\frac{304}{14}$.

ii. Ravine on the south-east of Bill, twelve miles north of Sháh-beg (the coral zone). Survey-number G $\frac{302}{43}$.

iii. Hill-scarp five miles north of Sháh Rhúi, on the Naig Nai, south-west of Jhangára. Survey-number G $\frac{302}{41}$.

iv. Naig-Nai valley, twelve miles south of Sháh Rhúi. Survey-number G $\frac{302}{40}$.

v. Scarp six miles south-east of Sháh-beg. Survey-number G $\frac{302}{24}$.

vi. Four miles south-west of Beynír Hill. Survey-number G $\frac{302}{23}$.

vii. About three miles south-east of Tóng. Survey-number G $\frac{302}{20}$.

viii. Survey-number G $\frac{302}{19}$.

ix. Ten miles north of Sháh-beg. Survey-number G $\frac{302}{18}$.

x. Scarp at Kúpo-jo-lak, or pass on the Mól range, west of Sháh-beg (same locality as G $\frac{280}{43}$). Survey-number G $\frac{302}{17}$.

xi. Mazaráni Nai. Survey-number G $\frac{298}{5}$.

xii. Síta Nai, Khírthar range. Survey-number G $\frac{298}{3}$.

xiii. Upper part of the scarp of the Myhír plateau, west of Thána Sháh-beg. Survey-number G $\frac{280}{43}$.

xiv. Hills east of Thána Sháh-beg. Survey-number G $\frac{280}{41}$.

xv. Hills east of Thána Sháh-beg (nearing Páni gúmbök from the west). Survey-number G $\frac{280}{40}$.

xvi. Pír Gáji, west of Sehwan. Survey-number G $\frac{226}{48}$.

xvii. Nari Nai, Sehwan district. Survey-number G $\frac{226}{47}$.

xviii. Amra Hill, Bárri Nai, Shikárpur district. Survey-number G $\frac{226}{46}$.

xix. Mazaráni Nai, hills west of Lárkhána. Survey-number G $\frac{226}{39}$.

xx. Cliff-section of Kadeji gorge, about thirty miles east-north-east of Karáchi. Survey-number G $\frac{226}{31}$.

Illustrations of the Species in Plate LIII.

Fig. 1. Abactinal view of a regularly convex, subdepressed form: natural size.
2. Longitudinal profile of the same: natural size.
3. Abactinal view of a high, subconical, and rather elongate, form: natural size.
4. Longitudinal profile of the same: natural size.
5. Actinal view of the same: natural size.
6. Abactinal view of a broad-petalled variety: natural size.
7. The peristome and surrounding parts of the test: magnified.
8. Abactinal view of a small subrotund test: natural size.
9. Longitudinal profile of the same: natural size.
10. Actinal view of the same: natural size.
11. The peristome and surrounding parts, from the same specimen: magnified.
12. Portion of an ambulacral petal, to show the ornamentation: magnified.
13. Actinal view of a small tumid test: natural size.
14. Longitudinal profile of the same: natural size.

2. Echinolampas spheroidalis ?, *d'Archiac.* Plate LIII, Figs. 15–19.

The following is the diagnosis of this species given in the 'Description des Animaux fossiles de l'Inde,' p. 210 :—

Test oval, very inflated, slightly enlarged posteriorly near the posterior ambulacra. Apex scarcely more elevated than the upper part of the odd posterior interradium ; its distance from the anterior margin is two sevenths of the length of the test. Four generative pores, large, especially the posterior pair. Ambulacral petals short, straight, flush with the test or very slightly tumid, rather narrow, considerably contracted near their extremity; the anterior petal shorter and a little narrower than the others. Poriferous zones narrow, considerably arched, the companion zones in a petal very unequal in length; in the odd anterior ambulacrum the right poriferous zone is the longer, in the postero-lateral ambulacra the anterior zone is nearly one third longer than the posterior, and in the antero-lateral ambulacra the posterior zone is the longer. Interradial areas a little unequal in the neighbourhood of the apex; measured midway between the extremities of the petals, the lateral areas are the broadest. Actinal surface subplane; peristome situated a little anterior to the centre, subtriangular, bourrelets very slightly developed, phyllodes open. Periproct marginal, rather high. Tubercles rather crowded and slightly unequal, those in the neighbourhood of the peristome larger and more widely spaced.

MM. d'Archiac and Haime remark that the different examples examined by them varied only very little in their form. The largest specimen was more than 4 centim. in length; another measured 3·5 centim. in length, 3 centim. in breadth, and 2·5 centim. in height. The locality is given as "Chaîne d'Hala (Sinde)."

We have stated on a preceding page, when treating of the young forms of *E. Jacquemonti*, the grounds upon which we have referred several small tests in the Gáj collection to this species. Our specimens unfortunately are in a very bad state of preservation, and do not enable us to add anything further to our previous remarks, or to the description given above. We may, however, mention that the height and general tumidity of the test, the convexity of the actinal surface, the small size of the peristome, the absence of bourrelets, and the narrowness of the ambulacral petals are especially striking.

Dimensions. The largest example measures 32 millim. in length, 28·5 millim. in breadth, and 24·5 millim. in height. The smallest 20, 19, and 16 millim. in these dimensions respectively.

Localities. In the Gáj series of strata :—

i. North of Babba band, five miles east of Kadeji. Survey-number G $\frac{302}{44}$.

ii. Four miles south-west of Beynír Hill. Survey-number G $\frac{302}{23}$.

iii. Scarp at Kúpo-jo-lak, or pass on the Mól range, west of Sháh-beg (same locality as G $\frac{280}{42}$). Survey-number G $\frac{302}{17}$.

iv. Hills east of Thána Sháh-beg. Survey-number G $\frac{280}{41}$.

Illustrations of the Species in Plate LIII.

Fig. 15. Actinal view of the test of the largest specimen: natural size.
16. Abactinal view of another specimen, much crushed and weathered: natural size.
17. Longitudinal profile of the same specimen as fig. 15: natural size.
18. Actinal view of a small specimen: natural size.
19. Longitudinal profile of the same: natural size.

Family SPATANGIDÆ.

Subfamily SPATANGINÆ.

Genus SCHIZASTER, *Agassiz*, 1836.

1. **Schizaster Granti**, *Duncan & Sladen.*

A considerable number of examples belonging to this species are in the collection, but all are unfortunately more or less broken, crushed, or badly preserved. As the form was described in detail in the fasciculus on the Tertiary Echinoidea of Kachh and Kattywar it is unnecessary to repeat the description there given. The species is also found in the Nari strata of Sind.

Localities. In the Gáj series of strata:—

i. Scarp at Kupo-jo-lak, or pass on the Mól range, west of Sháh-beg (same locality as G $\frac{280}{42}$). Survey-number G $\frac{302}{17}$. Some specimens also bear the Survey-number G $\frac{302}{17}$.

ii. About three miles south-east of Tóng. Survey number G $\frac{302}{20}$.

iii. Naig-Nai valley, twelve miles south of Sháh Rhúi. Survey-number G $\frac{302}{40}$.

iv. Gáj river, Khírthar range. Survey-number G $\frac{228}{3}$.

v. Near the top of the pass, on the Mól range, west of Thána Sháh-beg. Survey-number G $\frac{280}{42}$ †.

vi. Cliff-section of Kadeji gorge, about thirty miles east-north-east of Karáchi. Survey-number G $\frac{226}{21}$.

vii. Pír Gáji, west of Sehwan. Survey-number G $\frac{226}{48}$.

2. **Schizaster sufflatus**, *Duncan & Sladen.* Plate XLIX, Figs. 7–9.

Test of medium size, nearly as broad as long, with the greatest breadth situated a little behind the centre. Marginal contour suboval, more contracted in front than behind, and deeply notched by the anteal sulcus. Apical disk slightly excentric posteriorly. Seen in longitudinal profile, the greatest height is situated considerably behind the apical disk, the abactinal surface sloping continuously from this point to the anterior margin, which is tolerably thick and tumid; whilst the region of greatest height is the summit of a convexity, which passes with a rather rapid curve to the posterior extremity. The periproct appears to have been rather higher in position than the middle of the posterior extremity. The actinal surface shows great convexity, especially in the region of the plastron. The sides are thick and tumid.

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† The number "42" is indistinct.

The apical disk lies at the base of the sloping interradial keels, and is remarkable for its apparent breadth, caused by the lateral pair of plates being wide apart. There are four genital pores, the posterior pair being larger and slightly wider apart than the anterior ones. They, as well as the posterior pair of ocular plates, are separated by the large wedge-shaped central madreporiform body. The anterior pair of ocular plates appear to have been extremely small, but the condition of the fossil does not show them satisfactorily. The odd anterior ocular plate is small and placed midway between the anterior pair of genital plates.

The odd anterior ambulacrum lies in a well-defined, tolerably deep, and broad groove, the margins of which are sloping, and the lateral keels are not remarkably high or thin, although they become angular and well defined as they approach the apical disk, and at the same time slope away. The floor of the groove is slightly rounded, and the poriferous zones are placed at its junction with the sloping lateral walls, appearing rather more on the floor than otherwise, at least near the apex. The pores are small and slightly elongate transversely, and are separated by a small granuliform prominence. The plates are very short and band-like and successive pores are consequently closely placed. The plates are further remarkable for the abruptness of the bending which occurs just internal to the inner pore of the pair, the portion of the plate which lies in the interporiferous area being reflected sharply backwards towards the apex at about 30° from the direction of the outer part of the plate (see fig. 9). It will also be noticed that the facets of the inner end of the plates have a peculiar curvature. Traces are visible of a few widely spaced granules on each plate, ornamenting the interporiferous area.

The anterior pair of ambulacral petals are large, wide, petaloid, placed in tolerably deep grooves, and are rather divergent, the included angle being, roughly speaking, about 90°. The grooves, which are wide and gracefully rounded outwardly, contract very little in breadth until they reach the proximal third of the length, where they commence to taper rapidly to a point. The anterior poriferous zone is bent with a slightly sigmoid curvature. The companion posterior zone proceeds for some distance from the apex at a right angle to the longitudinal axis of the test, is then rather sharply bent with a well-rounded curve, and proceeds almost straight towards the margin. It will thus be seen that the bending of the petal on its approach to the apex is very conspicuous, and that there is also a slight inflation of the petal near the distal extremity. The poriferous zones are wide and fully twice the breadth of the interporiferous area about the middle of the petal. The pores are elongate except near the apex, rather wide apart, distinctly conjugate; with adjacent pairs separated by a well-defined costa, which was probably ornamented by a row of granules. The first 10 or 12 pairs of pores in the anterior poriferous zone of the antero-lateral petals, and the first 6 or 7 in the posterior zone, are remarkably small, and those beyond increase in size very abruptly. The posterior pair of petals are about two thirds the length of the anterior pair, lanceolate in outline, with the greatest breadth a little removed from the middle of the petal towards the apex; from this point they contract gradually and slightly towards the outer extremity, which is not rounded or closed. At the apical extremity they contract rapidly to a fine point. The petals reach about halfway between the apex and the margin, and their course is straight. Their angle of divergence is about 66°, being that included by lines drawn along the median line of the two petals. The intervening odd posterior interradial area forms a rather low, but well-defined ridge, narrow for a short distance from the apex, but rapidly becoming broader and disappearing in the generally convex or arched posterior region. The character of the poriferous zones is similar to that of the anterior pair of petals; the interporiferous area, however, is relatively narrower, and the posterior poriferous zone is remarkably broad midway between the extremities.

The interradial areas have a slightly gibbous or arched character, and their respective columns greatest in the anterior column of the anterior interradia and the posterior column of the postero-lateral interradia; but, as far as can be judged from the imperfect preservation of the fossil, the character does not appear to have been greatly emphasized.

Nearly the whole of the posterior extremity of the test is destroyed, but traces remain which indicate that the periproct was rather high in position.

The peristome is very excentric in front, but nearly the whole of the actinal surface is destroyed or unfitted for description.

Traces of two fascioles are present, a peripetalous and a latero-subanal. Judging from the only clear trace of the latter which remains, it appears to have been very narrow. The surface of the test is much too weathered to allow of any detailed account being given of the course or position of these bands.

The ornamentation of the plates is nearly all destroyed, but that on the abactinal surface appears to have been small and widely spaced.

Remarks. Notwithstanding the very unsatisfactory state of the single example under notice, the details above given are sufficient to indicate that we are dealing with a distinct species; and on these grounds we have ventured to give it a name, although the description is unfortunately imperfect. *S. sufflatus* is distinguished from *S. Granti*, with which it is associated, by the altogether different marginal contour of the test, by its more uniformly convex and less sloping abactinal surface, by the different form of the paired petals, the antero-laterals wanting the characteristic curve at the outer extremity, and by the relatively much longer and differently shaped postero-lateral petals; the character of the odd anterior ambulacrum is also different.

Dimensions. Length of the test 40 millim., breadth 38 millim., height 26·5 millim.

Locality. In the Gáj series of strata: Naig-Nai valley, twelve miles south of Sháh Rhúi. Survey-number G $\frac{302}{40}$.

Illustrations of the Species in Plate XLIX.

Fig. 7. Abactinal view of the test: natural size.
8. Longitudinal profile of the test: natural size.
9. Ambulacral plates in the odd anterior ambulacrum: magnified.

Genus MOIRA, *A. Agassiz*, 1872.

1. Moira, sp. ?

A single small example in the Gáj collection probably belongs to this genus. It is, however, so badly preserved, and with nearly the whole of the abactinal surface obscured by matrix, that accurate determination is impossible; we therefore refer it to the genus with doubt, and place its occurrence on record in the hope that future discoveries will furnish more satisfactory material. We were led to consider this specimen as a species of *Moira* on account of the indication of the presence of a narrow slit-like petal, and of the peculiar ornamentation on the neighbouring plates. The actinal surface is well preserved, and its outline is very near to that of *M. antiqua*, nobis, from the Miocene of Kachh.

Dimensions. Length of the test 16 millim., breadth 15 millim.

Locality. In the Gáj series of strata: Entering the hills on the road from Jangri to Búla Khán's Thána. Survey-number G $\frac{280}{28}$.

Genus MEOMA, *Gray*, 1851.

1. Meoma, sp. ?

There is a fragment of part of an interradial area of a large Spatangoid in the collection on which the remains of a well-defined, angular, and deeply re-entrant fasciole are preserved. Amongst the general miliary ornamentation of the plates are small, well-spaced, primary tubercles, both within the fasciole and on the adjacent plates without, where, however, they are smaller and diminished in size as they recede from the fasciole. The ornamentation recalls in a striking manner that of *M. ventricosa* (Lam.), Lütk. Unfortunately the fragment alone is insufficient for the determination either of species or genus, and we therefore merely place its occurrence on record.

Locality. In the Gáj series of strata: Near the top of the pass, on the Mól range, west of Thána Sháh-beg. Survey-number G $\frac{280}{42}$.

Genus BREYNIA, *Desor*, 1847.

Large Urchins well characterized by the presence of peripetalous, internal, and subanal fascioles. There are large tubercles with deep scrobicules, limited by the peripetalous fasciole; but they are absent in the posterior ambulacrum. The internal fasciole crosses the four petals, and their pores situated within its area differ from those without and may disappear.

This genus was placed by MM. d'Archiac and Haime amongst the Nummulitic fauna of Sind, and their species *Breynia carinata* was described in their great work, which has so often been quoted in this Monograph, on p. 216, and delineated on their plate xv, fig. 4.

We have noticed the same species in our description of the Miocene series of Kachh ("The Tertiary Echinoidea of Kachh and Kattywar," Pal. Indica, Ser. XIV. p. 66, Plate X), and also on page 228 of this Monograph. There is now no doubt about the correct geological horizon of the genus in the Tertiaries of Western India, for

Mr. **Blanford** states that he has never seen the form in any other than a Miocene formation, and it is evident that the specimen from the Khirthar series (a solitary one) was not found in place. Moreover the species abounds in the Gáj beds and not in the Nari of Sind. We may assert that the species is the most characteristic of the Miocene of Sind.

With regard to the species *Breynia carinata*, we were able to correct some of the descriptive parts of **d'Archiac** and **Haime's** notice of their unfortunately ill-preserved specimens, in our Monograph of the Kachh Echinoidea, and Messrs. **Medlicott** and **Blanford** had previously indicated the presence of minute pairs of pores within the area of the internal fasciole. Since the publication of our Monograph a great number of specimens have been examined from the Gáj series, and some are in a most wonderful condition of preservation. We have now evidence regarding the correct shape of the form in the adult stage and when half-grown, and we have proofs of the comparatively slight variation in the shape and structure of this most highly specialized Spatangoid.

The description of the species by its founders was admirable, and we could have wished that they could have had our opportunity. We propose therefore giving the translation of the diagnosis of MM. **d'Archiac** and **Haime**, and to add the results of our examination of good specimens.

1. BREYNIA CARINATA, *d'Archiac & Haime*. Plate LIV, Figs. 1–9, and Plate LV, Figs. 1–8.

The test is elongate, low, bilobed in front, narrowed behind and truncated posteriorly; upper surface very slightly convex.

The measurements are—length 9 centim., breadth 7 centim., height 3 centim.; a second is 6 centim. in length.

Actinal surface of the test almost flat, except near and in front of the anus, where it presents, in the median line, an oblong and subcarinate keel. In some individuals the odd interradial area is slightly raised above the anus.

The four generative pores are small and close; the madreporic body is indistinct, oval, and elongate in the antero-posterior direction of the test. The plates which surround the apical disk immediately, are surrounded by an oval-shaped non-sinuous fasciole, rounded behind, and the anterior branches of which become close on the level with the ends of the antero-lateral ambulacra. Those plates which belong to the ambulacra within the fasciole, are perforated by very small pores in a series which forms an angle with the line of the other ambulacral pairs. The large pairs of pores of the petals commence at the outer edge of the internal fasciole, and are formed of large pores which open into transverse grooves separated by great costæ. The poriferous zones are in shallow grooves, are broad and straight; they close the petals externally. The poriferous zones of the antero-lateral ambulacra are shorter than those of the posterior, and those of the same ambulacra are unequal amongst themselves. In the antero-lateral petals it is the anterior zone that is the shortest and which commences furthest from the apical system. In the posterior petals, the anterior poriferous zone is the longest. The petals are moderately broad and long, and angular externally. The posterior petals are rather close and the antero-lateral are wide apart and placed almost transversely. The anterior ambulacrum is not petaloid; it is in a slight groove and the pores are but slightly distinct.

The peripetalous fasciole is very slightly sinuous, is subelliptical and rather close to the ends of the petals. The anterior and the antero-lateral interradia have large tubercles on those portions which are within the peripetalous fasciole. The tubercles are large, close, and sunk in deep scrobicules. The odd interradium and also the ambulacra are nearly smooth or finely granular. Actinally the ambulacra are smooth and only marked by the pores, which are distinct. In front of the anus in the median line there is an oblong and subcarinate-shaped mass of granules. The interradia on this surface are covered with large, close, and prominent granules.

The mouth is situated at the anterior one fourth of the distance from the front to the back of the test. The anus is marginal, the periproct large, angular upwards, sub-oval, and elongate in the direction of the vertical axis of the test. In some individuals the odd interradium is raised into the shape of a keel.

Correct as this diagnosis is for the most part, yet there are several misconceptions in it and there are some very important details omitted which would fix the species very decidedly. These defects are not to be laid to the charge of the distinguished French *savants*, but to the imperfect nature of their specimens.

Shape. The shape is somewhat variable, and there are three types which clearly belong to this species and which have slightly different shapes. Taking one of these as the normal form (Plate LIV, Fig. 5), it may be described as long, low, and rather broad, is generally ovoid, rounded in front except where there is a broad and shallow marginal groove, broadest a little in front of the centre and on a line with the apical system, the same breadth extending backwards for a short space and then gradually diminishing until a decided posterior truncation is reached, so that there is a nipping in behind, especially posteriorly to the ends of the posterior ambulacra. The margin of the base is rather sharply curved, and immediately above, the test is tumid in the anterior regions, almost vertical, for a little height on a level with the posterior ambulacra, sloping more gently along the course of the posterior ambulacra to the side of the truncation, and finally truncated posteriorly, for the depression in which is the periproct, the surface looking backwards and downwards. The front of the test rises, on either side of the broad anterior sulcus, in a somewhat sudden manner, and after being vertical, slopes with a very broad curve to a comparatively flat area, with a very slight ascent posteriorly and behind the apical system. This gentle slope persists to about one third of the distance from the apical system to the edge of the truncation, but the slope then commences to be in the opposite direction and is a little more decided than in front. So the highest point of the test is behind the apical system, the antero-posterior curvature after the dorsal surface has been reached being slight. There is some slight angularity of the margins of the test, and the slight lateral swellings which produce them are one on the edge of the anterior interradium, just behind the faint keel of the side of the sulcus; another on the lateral interradium close behind the line of the antero-lateral ambulacrum; and the third still further behind and at the spot whence the slope towards the truncation takes its rise on the flank of the test. The three lateral swellings, of which the middle one is the least developed, are symmetrically placed on both sides of the test, and although they do not appear to relate to any structural peculiarity on the dorsum, they are, on the actinal surface, the points whence as many series of concentric lines of small tubercles arise, giving a very varied appearance to the ornamentation of the base.

The actinal surface of the test is not flat, for there is a slight hollowness around the mouth, a gentle convexity of the anterior interradia from before backwards, a less convexity of the lateral interradia from side to side, and a decided carination along the median line of the sternum, culminating far back in a pointed downward-projecting summit. This last is crossed by the subanal fasciole and forms the spot on which the test rests posteriorly. Since the base rests on this projection and on the convexity in front of the peristome, the greater part of the actinal surface does not touch the supporting substance, and there is a decided space seen especially between the peristome and the surface on which the Urchin rests. The posterior lip of the peristome projects downwards, is semi-nodular, and carries many large granules.

Behind the posterior projection of the keel and within the subanal fasciole, the test slopes upwards and backwards, to reach the rim of the broad smooth surface, which is below the depression for the anus.

The lower part of the truncation, or that which is within the semicircular area enclosed by the subanal fasciole, is convex from side to side and projects along the median line as a faint ridge. The smooth surface above the upper part of the fasciole is very concave and at the upper part of this depression is the periproct. Its normal shape is pyriform, the broad base being towards the actinal part of the test, and the narrow and angular upper part being close below the edge of the low rounded broad keel of the odd interradium. In that sense the periproct is marginal; but it is only near, and not in or on, the upper and posterior margin of the odd interradium. It is by no means marginal according to the usual application of the term, for it is some distance above the posterior margin, even if that part is supposed to be the top of the subanal fasciole. The posterior edge of the odd interradium forms a broad and low arch, and where the point of the periproct comes near it the edge is thin; but on either side of this central spot there is a thickening of the sides of the arch. The posterior structures give a greater vertical thickness to the end of the odd interradium than is seen in the anterior part of the test.

The sulcus for the anterior ambulacrum is well developed as far back as a line a little in advance of the anterior poriferous zones of the antero-lateral ambulacra, where it becomes shallower but broader; thence it diminishes to the apical system. This is usually in a continuation of the shallow groove, which may even pass as far back as the posterior angle of the internal fasciole.

The apical system is small, narrow, broader behind than in front, and long, the length being due to the backward projection of the madreporite, which passes as a triangular structure between the highest plates of the odd interradium (5) and separates plates 1 and 2 of zone "*a*" from their fellows of zone "*b*," on the other side of the median line. The madreporite may be traced in some specimens in between the basals "2" and "3"; again, a similar intrusion of it exists between the anterior and posterior basals, a few foramina being seen as lateral offshoots of the main mass of the madreporite. The apex of this triangle is close to the posterior suture of the second plate. The pairs of pores for the ducts of the generative glands, and the pores themselves are close: the anterior pair are slightly smaller than the posterior, and are closer, rather oval in outline, and their long axis is oblique, the direction being outwards and forwards and therefore away from the long axis of the test. The anterior pair of basals are small and the openings occupy the greater part of them. The lateral basals behind these last are larger, and their pores are larger than those just mentioned, and although but slightly varying from a circle in outline, it is clear that their long axis is directed forwards and slightly inwards.

The anterior ambulacrum is very long, and is very narrow on the dorsum. The divergence of the poriferous zones is very slight from the apex to the margin; there it contracts again for a short space and again expands before reaching the peristome.

At the commencement and near the radial plate, the pairs of pores are numerous and close in succession, and the pores, placed one before the other, are separated by a small but prominent granule. Further out, but still within the line which would unite the transverse portions of the antero-lateral ambulacra, the pairs of the pores of the anterior ambulacrum are in slight depressions surrounded with a minute granulation. As the plates are large near the position of the crossing over of the internal fasciole, the pairs of pores are further apart there, and their distance increases gradually to the margin. On the actinal surface the plates of the ambulacrum are large, and expand so that the second from the peristome, on both of the ambulacral zones, is the largest.

The peripodial processes of this, and indeed of all the ambulacra, are large, ear-shaped, slightly sunken below the level of the granular surface of the test, slightly tumid around, or on one side of the pore, which is usually elongate. The peristomial margin of the ambulacrum has the plate on zone "*b*" large, and of course perforated by two pores, each in a peripodial process; but the edge of that plate corresponding to the interradium no. 3 is not straight, but has a re-entering angle placed on a line with the space between the two peripodial processes. Hence the plate is nipped in as it were, and this condition existing in the plate "*a*" of ambulacra no. 4 increases the breadth of the peristomial plate of the interradium 3. The peristomial ambulacral plate "*a*" has the usual solitary pore, and is decidedly smaller than its neighbour of the zone "*b*." The plate is contracted near the margin, and the second plate of the same zone comes not very far from the peristome, so that its peripodial process lies anterior, and towards the median line in relation to the pore of the marginal plate. The peripodial process of this marginal plate is nearer the margin of the peristome than that of the plate of zone "*b*," and this last is nearer the median line of the ambulacrum than the other. The expansion of the actinal plates of the ambulacrum is almost without ornament; but the plates are very sparely marked with distant, yet distinct, granules; the sutures are in shallow depressions, and the plates are slightly tumid. There are no secondary tubercles resembling those of the interradia on the ambulacral surface, the comparative plainness of which contrasts with the regular and large ornamentation of the interradia.

Within the groove at the margin of the test in front, the ornamentation of the ambulacrum is small and closely granular, and there is an indefinite series of very small but perfect tubercles, which may be traced to the apical region. The position of the somewhat broken series is just between the pairs of pores and the median line. These little tubercles become larger actinally and wider apart. Finally the actinal surface of this ambulacrum, although it appears flat, is slightly convex from side to side, and there is no median grooving; but the peristomial plates rise in the proper position of the test, and form part of the anterior margin of the peristome.

The antero-lateral ambulacra are nearly transverse in those parts which are external to the internal fasciole, especially the anterior poriferous zone. This may be slightly curved, so as to bring the outer end more to the front, or there may be a double curving, which renders the zone rather sinuous, there being a convexity forwards in the neighbourhood of the fasciole.

The posterior zone is wide apart from the anterior close to the internal fasciole, and either there is a nearly straight part between this part and the external end of the ambulacrum, or there is some slight sinuosity of the posterior zone. There is much variation in the relative direction of these two zones, and in some large specimens there is an anterior concavity of the anterior one.

The ambulacra now under consideration are angular at the external end of the perfect poriferous zones; within the internal fasciole the ambulacrum is also triangular, the base being at the fasciole and the apex at the radial plate. In this triangle the posterior zone of pores is nearly transverse, whilst the anterior zone slants from the pair of pores immediately in contact with the internal fasciole to the proper radial plate.

The poriferous zones outside the internal fasciole are broad, not very long, for they do not pass over the sudden curve of the test above the ambitus, and the pairs of pores are in deep and large depressions which are separated by costæ, thin and granular on the free edge, and thick and very solid where they merge into the floor of the poriferous plate.

The pores of each pair are large, wide apart, deeply seated, and the anterior row of the anterior zone and the posterior row of the posterior zone are larger than those of the other rows. The smaller pores are nearly circular in outline, and the largest are pyriform. The whole of the ambulacrum external to the internal fasciole is slightly depressed below the level of the interradia, but whilst the poriferous zones are in shallow grooves the interporiferous areas are rather tumid. These last are crowded with granules of at least two kinds, and some very small tubercles are found amongst them with tiny mamelons. Near the internal fasciole the granules and minute tubercles are arranged in more or less perfect rows parallel to the fore and aft running fasciole.

The pair of pores in the anterior zone next to the fasciole abort more or less; but they are really miniature representations of the larger. In many large specimens, however, the pair is only slightly diminished in size. The pairs of pores within the internal fasciole are small, rather close, and quite as numerous as the others. The pores are close, very small, except in the instance of the pair close to the fasciole, and their direction is transverse near the small radial plate and a little oblique further out.

The posterior poriferous zone within the fasciole has almost invariably, but not universally, three or four pairs of pores which are similar to those beyond the fasciole; they are smaller, especially that pair which is just within the fasciole and that nearest the first very small pair. Usually the second of these larger pairs is nearly as large as one of the outer set. The direction of these few pairs of pores is not in continuation with the line of the posterior poriferous zone from the angle of the ambulacrum, for it is almost transverse to the long axis of the test.

The very small pairs which continue the larger set to the radial plate are seven or eight in number, the pores are very small, and they are not separated by any ornament. The little pairs, however, are in slight depressions which are sunken in a granular ornament. The direction of their pores is forwards and a little outwards.

The outer angle of the antero-lateral ambulacra is formed by the approach and contact of the poriferous zones, not that the pairs of pores alter their direction and close like the radii of a part of a circle. The interporiferous area diminishes in antero-posterior dimension and becomes as it were thin, permitting the poriferous zones to come in contact. This is owing to a diminution in the breadth of the ambulacral plates towards the end of the series of great pores. Usually the poriferous plate at the end of the posterior zones is smaller than the others, and it gives a preponderance in length to those zones, for the pair on the outside of the anterior zones, corresponding in position to that pair which has just been noticed, is very much smaller. This anterior pair is in a simple depression, its pores are very small, and yet their direction is that of the larger. Further out the antero-lateral ambulacra take a different direction from those parts which have been described, become larger, both in height and in breadth, and this expansion proceeds as far as the edge of the test, where narrowing and increase in height occur. The direction of the lines of the pairs of pores of this part of the ambulacra is not in continuation with that of the main poriferous zones, but is oblique, and in the direction outwards and slightly forwards. On the side of the test the ambulacra bend slightly, with a convexity forwards, and are in advance of the peristome were a line to be drawn from it to the anterior edge of the ambulacral plates.

The pores of these extra-petaloid plates are exceedingly minute, and their direction is more or less transverse; but after a few plates there is only one pore to each, and it is not on the suture.

Below the edge of the test the plates diminish in breadth, and in a worn specimen there are five seen, the last being in its proper zone at the peristomial margin. The pores become larger on the actinal surface and are placed on the transverse sutures.

At the peristome the plates are slightly broader than further out, but they are not so high. In ambulacrum no. IV. the peristomial plate of zone *a* has two peripodial processes and that of zone *b* but one. Moreover the plate *a* is the larger. On the opposite ambulacrum no. II., the peristomial plate of zone *a* is the largest, and has two pores, each surrounded by a peripodium, whilst the smaller plate of *b* has but one, and there is a cavity in which a sphæridium was probably once placed. The ornamentation of the peristomial part of the ambulacra resembles that of the odd one; but in passing over the side of the test and on to the actinal surface to the third plate from the peristome, the plates have the ornamentation of the interradia. The peristomial edge of these ambulacra is a narrow, curved, plain ledge. There are usually one or two peripodial processes beyond those of the peristomial plates, and it is interesting to note, in some instances, that these peripodia occupy the place of a tubercle.

The posterior ambulacra are longer than the antero-lateral, are rather close, reach to the part of the test where narrowing commences, and have an extra- and an intrafasciolar part.

Beyond the fasciole, the outer poriferous zones are long, nearly straight, being slightly bent near it. Like all the zones, this one is slightly sunken. The general construction is that of the zones already described, and the number of pairs of pores is from twelve to twenty, according to the length of the individual.

The inner zone, beyond the internal fasciole, is shorter than the outer, commences on a line much behind it, is slightly wavy, and comes close to the outer zone so as to close the petal. The interporiferous area is slightly tumid, and ornamented as the antero-lateral area. Close to the internal fasciole the pairs of pores are smaller than elsewhere in that part of the zone, and, except in very large specimens, there are no large pairs within the fasciole.

Within the fasciole the direction of the pairs of pores of both of the zones changes, and some pairs of very minute pores pass towards the radial plate, with a direction forwards and inwards from the outer zone. They are in a slight groove. The internal poriferous zone within the fasciole is longer than the outer, its direction is almost parallel with the median line behind the apical disk, and it is separated from its fellow by the narrow odd interradium.

The actinal part of these ambulacra is very broad on the side of the sternum, and their plates are unusually large and distinct.

At the peristome the width of the zones is less than further back; but it is great nevertheless, and the two sets of peristomial plates of the ambulacra V. and I. are so large that they contrast with the narrow posterior lip, and the still narrower peristomial ends of the interradia on either side. The plates at the peristomial margin of zones *a* of ambulacrum I., and *b* of ambulacrum V., are larger than the plates of the zones *b* and *a* of ambulacra I. and V. respectively.

The larger plates, moreover, are pierced by two pairs of pores and have two peripodia on each. The outer and smaller plates have only one peripodial process. There are deep depressions close to the peripodia for the sphæridia in all the peristomial plates of these ambulacra of the bivium. With regard to the other plates of the posterior ambulacra, they are symmetrically placed on either side of the sternum, and it will therefore only be necessary to treat of those of one ambulacrum. Taking no. 1, it will be found that in zone *a*, the second plate immediately posterior to the peristomial with two peripodia, is longer than broad, large, and has a peripodium at the anterior and outer angle, close to the transverse suture between the first and second plates. A few granules are borne upon it. Plate 3 is larger than the other two combined, and is long and broader than the last. The peripodium is small and close to the suture at the antero-external angle. The fourth plate is nearly as large as the third; but there is only a simple pore in it, and it is some distance from the anterior suture. Plate 5 is about half the size of the last-mentioned, and is longer than broad; the pore is very small, and is nearer to the anterior and inner angle than to the outer. The sixth plate is of course much smaller than the fifth, is broader than long, and is placed obliquely, the greatest length being in the direction outwards and forwards. This plate bounds the episternum externally, and towards the median line of the test is only separated from its fellow plate of the opposite side by the narrow junction of the episternal and subanal plates. The plate is therefore one of those which are crossed by the subanal fasciole, and the inner part is long from the median line outwards and forwards. The pore is small, and placed close to the episternum at the inner and anterior angle of the expanded part, which is external to the fasciole. The narrow internal part of the plate forms with six other corresponding parts of plates one side of the subanal plastron, which is limited by the subanal fasciole. The part of the plate within the fasciole is broad from within outwards, and short in the antero-posterior direction, and this is the shape of the other parts of plates entering into the construction of the shield.

The ornamentation of the plates within the fasciole is of a very elaborate kind, consisting of a row of perfect small tubercles on each plate. The tubercles are minute near the fasciole, and increase in size to the inner end of the plates. Plates 7 to 11 decrease in size and breadth, for they are on the flank of the widening interradial plate no. 4. Each plate of this group has a part outside of the fasciole which is almost plain, and a part within which has the ornamentation of the sixth plate. The pores are double in each of these plates, and are placed on the anterior suture, just within the fasciole, and in the narrow groove between the ornamented parts. The pores of each pair are close, and are excavations in the sutural edge. The six pairs of pores form a curve within the fasciole, and the last pair is remotest from the median line. Taking the other zone into consideration it will be noticed that the peristomial plate (1, of *b*) has one peripodium and a depression for a sphæridium, and that the plate is smaller than *a* 1. Plate *b* 2 has one peripodial process and a sphæridium pit, and the posterior suture of this small plate does not extend posteriorly to the anterior half of the plate *a* 2. Plate 3 is long and narrow, and the imperfect peripodial process nearly occupies the whole of the anterior part. Plates 4 and 5 are large, long, and broad, and the pores are small and near the anterior sutures. Plate 6 is almost square, and is much larger than its fellow of zone *a*; the pore is small and some distance from the anterior suture. Plates 7 to 11 are small and diminish in length and breadth; they are more or less rectangular and somewhat curved, with the convexity backwards. Their pores are single, and each is on the anterior suture. The twelfth plate is larger than those immediately anterior to it, and the others, which are of higher number, increase in size until the crossing of the peripetalous fasciole. The ornamentation of the ambulacral plates after the second pair is very simple. In well-preserved specimens there are always distant granules to be seen, which become rather crowded near the interradia. In some specimens there are linear depressions on the plates, one to each, and there are two minute granules in each.

The peristome is crescent-shaped in front and at the sides, and the posterior lip projects forwards and downwards, and is at a lower level than the rest of the mouth, the whole being within a concavity in the anterior third of the actinal surface.

The peripetalous fasciole is narrow and continuous. It crosses the posterior interradium about halfway between the end of the posterior petals and the edge over the anus, curves towards and round the end of the posterior petals, and passes forwards with a slight convexity towards the ambitus, to reach the antero-lateral ambulacra at some little distance from the termination of the large pairs of pores. During this last part of its course the fasciole bounds externally an area on which are four rows of large sunken tubercles, the outer row being the longest as a rule. From this spot the fasciole passes with a slight curve to the anterior groove, and crossing this at some distance from the margin of the test, meets its fellow of the opposite side. In this part of its course the fasciole bounds a tuberculate area where four more or less developed rows are seen.

The internal fasciole is also narrow, and is usually situated in a very shallow groove; but sometimes this becomes indistinct. Posteriorly this fasciole forms a wide angle between the closely approximated poriferous zones of the posterior ambulacra (zones *b* of no. V. and *a* of no. I.). It crosses these poriferous zones, dividing the large from the minute pairs, at about the seventh interradial plate from the apex. The fasciole then passes forwards and outwards to reach the outer poriferous zones of the posterior ambulacra; thence it pursues the same line, and shortly crosses the posterior poriferous zones of the antero-lateral ambulacra, at spots on a line drawn across the apical system. In both of the approximated zones of the ambulacra there are some pores separated from their fellows. From these places the fasciole passes, being rather narrower, forwards. It crosses the antero-lateral ambulacra and in front of the first large sunken tubercle of the anterior interradia. Passing a little further to the front and nearly to the second tubercle the fasciole crosses the anterior groove, the broad keels on either side of it and the narrow odd ambulacrum on its floor. This part of the fasciole is narrow and is curved forwards.

The subanal fasciole is well marked and broad, and environs a more or less uneven surface irregularly semicircular in shape. The convexity of the path of this fasciole is forwards to the keel on the actinal surface at the junction of the sternum and episternum. The band is limited posteriorly by the plain surface beneath the anal opening. The fasciole crosses the posterior ambulacra and includes no less than seven plates of the inner zones, and these form an angular surface on both sides of the episternum and succeeding interradial plates.

The pairs of pores of the included zones are just within the fasciole, and those of the outer zones are considerably beyond it. The ornamentation of these plates has been noticed; but it is to be remarked that the fasciole is made up of exceedingly minute and crowded granules with a row of large ones on the edge. There is a median line of small tubercles in the area, and a plain surface above it.

The anterior interradia on the dorsum are minutely tuberculated just above the margin, and still higher up a minute granulation separates some slightly larger tubercles into irregular transverse lines, which are complicated in some individuals by the presence of offshoots of the front part of the fasciole. The great sunken tubercles are between the fasciole and the keel on the side of the anterior groove. Usually there are three irregular rows of them, and one solitary tubercle is nearest the crossing point of the internal fasciole and the anterior poriferous zones of the antero-lateral ambulacra. There are about 13–15 tubercles in the rows in a typical adult form, and there is some variation in the size of those of the same row. The smallest tubercles are in the outer row and the most perfect are in the rows nearest the apex.

A typical tubercle has a deep sunken scrobicule, departing slightly from the circular in outline. The boss is much smaller than the scrobicule, rises suddenly from its centre as a cylindrical cone, and comes very slightly above the general level of the surface. It is capped by a small narrow perforate mamelon, which is much smaller than the top of the boss, which has a wide groove around its base. On the anterior part of the collar around the groove are a few close nodular processes, simulating a rough crenulation; but this condition is only found on one part of the periphery of the boss. The bosses are in the middle of the scrobicules, and these have sharp edges which are separated by much close granulation. The rows of tubercles in the lateral interradia are longer and contain more tubercles than the anterior sets. Three rows and a solitary, or, in some instances, two tubercles, are seen in the lateral interradia, and the number is from 20–24. There is some variation in the size. The same kind of granulation separates these tubercles as is the case in the anterior interradia.

The posterior interradium is without tubercles on the dorsum.

In the anterior interradia, on the actinal surface, there are some closely placed tubercles, which are on the outskirts of the broad and comparatively bare surface of the ambulacrum in front of the peristome. The tubercles increase in size and distance from the margin to the ambulacrum and they are placed upon flat scrobicules, raised a little at the edge here and there, with a few small granules between them in some places. The boss of the tubercles is almost cylindrical and only slightly conical; it slants more or less and is usually placed not in the centre of the scrobicule. The mamelon is small and tumid; it is perforate and the collar around its union with the boss is irregularly nodular, and in that sense is crenulated, but usually not all round. It is evident that the anterior interradia come in contact with the peristome by means of very narrow parts of the first plates, the surfaces of which are granular. The lateral interradia actinally are well covered with regularly placed tubercles of the same type as those of the anterior interradia; the tubercles are closer at the ambitus, whence they radiate excentrically from two or three centres, and they are also much smaller near the margin and the boss is on one side of the flat scrobicule. The ornamentation is small and in more or less parallel lines near the ambitus and above.

The lateral interradia come in contact with the peristome by means of a narrow process.

The posterior interradium is narrow and rounded from side to side on the dorsum, but there is no prominent keel there.

On the actinal surface the interradium presents an exceedingly long plate 1, which has a narrow, tumid, and highly granular posterior mouth-lip in front and a long narrow process behind. This plate 1 is bounded, on either side, by the three plates of the posterior ambulacra, nearest the peristome, the pointed posterior end being on a level with the termination of the first half of the third plate on either side. The plate is very slightly raised and has the simple granular and distant ornamentation of the broad ambulacra on either side. The sternum is small and keeled posteriorly, and generally rounded; it is closely and minutely tuberculate and granular, and is limited on either side by the broad ambulacra, and behind by the subanal fasciole and the episternum. One plate on either side is posterior and higher than the episternum, and then comes the periproct; this part when well preserved is in a broad and deep hollow, and the surface of the subanal plates is smooth.

There are evidently three types of this species, which are of racial value and no more—the normal, the broad, and the long.

The amount of structural difference is not specific, nor is it constant. The following differences have been noticed:—The presence of more large pairs of pores within the fasciole, and the greater breadth and area of this posteriorly; the indistinctness of the peripetalous fasciole in front, and the number of the great sunken tubercles.

Measurements of specimens of *Breynia carinata*, d'Arch., from various localities in the Gáj series:—

α. Length 70 mm. Breadth 64 mm. Height 31 mm.
β. „ 66 mm. „ 52 mm. „ 26 mm.

Locality. α. Hills about two miles north of Kadeji. Survey-number G $\frac{224}{91}$.

β. Cliff-section of Kadeji gorge, thirty miles E.N.E. of Karachi. Survey number G $\frac{226}{21}$.

Length 51 mm. Breadth 46 mm. Height 20 mm.

Locality. About three miles S.E. of Tóng. Survey-number G $\frac{302}{20}$.

Length 67 mm. Breadth 53 mm. Height 27 mm.

Locality. Ten miles N. of Sháh-beg. Survey-number G $\frac{302}{18}$.

Length 62 mm. Breadth 48 mm. Height 24 mm.

This form has a decided roof-shaped keel in the odd interradium dorsally.

Length 54 mm. Breadth 45 mm. Height 23 mm.
„ 52 mm. „ 42 mm. „ 22 mm.

Locality. Hills east of Thána Sháh-beg. Survey-number G $\frac{302}{41}$.

Length 50 mm. Breadth 38 mm. Height 24 mm.
„ 46 mm. „ 36 mm. „ 22 mm.
„ 45 mm. „ 34 mm. „ 21 mm.
„ 37 mm. „ 27 mm. „ 16 mm.

surrounding a triangular space, and merging into the narrow path which is carried over the margin as a series of long plates perforated by one pore. The ornamentation of the actinal surface is of small tubercles, increasing in size towards the mouth and becoming wider apart also; they are in radiating series and start as it were from certain points on the margin.

The tubercles, which are small, are upon the usual flat scale-like bases, and are perforate as well as irregularly crenulated.

Very often the mamelon and part of the top of the boss are deformed.

In one specimen the odd ambulacrum can be seen fairly well and it is very narrow at the apex, in a very slight groove for a short distance, and the pores are small and environed with granules. Near the apical system there are pairs of pores which soon become placed with one pore well in advance of the other; nearer the margin there is only one pore to a plate, and this is the rule over the margin.

The plates of this ambulacrum become larger actinally; but the only double-pored plate is that at the edge of the peristome in the zone "*b*" plate 1 of ambulacrum III.

The part surrounded by the subanal fasciole looks backwards and downward, and is heart-shaped. The anus above it is large, elliptical, and is in the posterior narrow and tumid vertical truncation.

The test when mature is ovoid in outline, but it is truncated posteriorly. It is depressed and there is a general but only moderate slope to the median line of the actinal surface from the rather sharply rounded margin. The highest point is behind the eccentric in front apical system. A younger specimen is proportionally longer in relation to breadth than the more mature forms, and an intermediate specimen is deficient in the anterior breadth which is noticed in old forms. Growth seems to take place more decidedly in length and breadth than in height.

Length of large specimen 9 centim., breadth 78 mm., height 42 mm.

Length of middle-sized specimen 73 mm., breadth 66 mm., height 37 mm.

Length of small specimen 44 mm., breadth 35 mm., height 25 mm.

Localities. Gáj series or Miocene of Sind: Amra Hill, Barri Nai, Pír Gáji, west of Sehwan; Naig-Nai valley. Survey numbers G $\frac{224}{48}$ and G $\frac{202}{40}$.

Illustration of the Species in Plate LV.

Fig. 9. Actinal view of a medium-sized form.

The full-sized specimens of this species recall the genus *Metalia* on account of the comparatively thin margin and shape; but there is no anterior sulcus, the actinal surface is convex, and the abactinal tubercles are not those of the genus. On the consideration of the whole of the structures the form appears to be inseparable from the genus *Brissus*, Klein.

IV. *Remarks on the Species.*

Besides the remarks made hitherto we make the following observations.

The predominant forms of regular Echini in the Gáj series belong to the genera *Cidaris*, *Cœlopleurus*, and *Hipponoë*. The species of the last-named genus attain truly gigantic proportions; and from the fact that they have not been found in older strata, as well as from their not infrequent occurrence in the Gáj series, constitute a characteristic feature in the horizon under notice, and help to emphasize its modern facies. Both the Sindian forms of *Hipponoë* we consider to be specifically distinct from the *H. Schneideri* described by Böhm from the Tertiary beds of Madura*.

Echinus subcrenatus, unfortunately only represented as yet in the Gáj collection by fragmentary specimens, is in like manner the first appearance in the Sind Tertiaries of that cosmopolitan modern genus, and bears evidence to the approach of the present fauna.

Of *Cidaris* we have been enabled to describe two distinct species; but the presence of other members of the family is proved by the very numerous series of spines obtained by the Survey. *Cidaris opipara* presents alliances to the two Cidarids described from Kattywar and has a distinctly Tertiary facies. *C. excelsa* foreshadows in several respects the characters of the recent *Goniocidaris*. A large number of the isolated spines have a striking Phyllacanthid facies.

The two species of *Cœlopleurus* are very common in the Gáj deposits, and the condition of preservation of many specimens is unusually perfect. There has therefore been no difficulty in comparing these forms with the modern *Cœlopleurus Maillardi* of the Indian seas. The principal distinction between the Miocene and the Recent species consists in the greater height and want of obliquity of the interambulacral plates of the modern type. We have shown in a communication to the Linnean Society †, that the remarkable arrangement of the ambulacral plates noticed in the fossil forms is well seen in the recent, and we have indicated that this arrangement, more or less modified, is a character of the Arbaciadæ.

The alliance of the modern and the fossil species is very close, and doubtless, did the nature of the fossilization permit, the remarkable dowelling and other structures of the sutures of the plates of the modern form would be found in the ancient.

The new species *Cœlopleurus Sindensis* has a granular and hardly tubercular condition of the ambulacra above the ambitus. In all of these *Cœlopleuri* the optic pore is double and opens on the adoral edge of the radial plate, a process separating the pores.

It is perfectly evident that d'Archiac and Haime were mistaken regarding the Nummulitic derivation of *Cœlopleurus Forbesi*.

Finally it may be said that these Miocene species are about as closely allied to the Oligocene form as they are to the recent.

The Temnopleuridæ are well represented in the Miocene of Sind, and they clearly characterize, in Sind as well as in Kachh and Kattywar, a higher geological horizon than that given to them by our predecessors in the study of the fossils of Western India.

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* Denkschr. K. Akad. Wissensch. Wien, Bd. 45 (1882), p. 362.

† Journ. Linn. Soc., Zool. vol. xix. pp. 25–57.

We have given our reasons for not associating the forms which were described by the great French palæontologists as members of the genus *Temnopleurus* with any other group than that of the genus *Temnechinus*, Forbes. The common fossil *Temnechinus Rousseaui* occurs, and we find also our *Temnechinus affinis* in Sind as well as in Kattywar. But probably the most interesting forms of the genus found in Sind are the two new species *T. stellulatus* and *T. Gajensis*, for their alliance with *T. lineatus*, Dunc., of the Australian Tertiaries and with the Australian species of the unfortunately named genus *Paradoxechinus*, Laube, is evident.

The new genus *Lepidopleurus* is a Temnopleurid with angular and adorally overlapping coronal plates. We take this opportunity to remark that the new genus has the ambulacral characters of the Triplechinidæ as is usually described and that they are totally different from those of the Arbaciadæ.

The Clypeastridæ are largely represented, and *Clypeaster* is a distinctly dominant form in the Gáj series. The species which we have associated with the *C. profundus* of d'Archiac and Haime is probably the most numerously represented Urchin in the collection. It has been obtained from many different localities and presents a wide range of variability.

C. pulvinatus in its general habit has much the appearance of a gigantic *C. scutiformis*, the present inhabitant of tropical seas. *C. complanatus*, comes nearer perhaps to *C. placunarius* (Lam.), Agass., than any other form, but is well distinguished. *C. pelviformis* is remarkable for its deep basin-shaped actinal surface and widely spaced scrobicules.

The genus *Echinolampas*, which by its numerous species formed such an important feature in the fauna of the underlying Nari and Khirthar series, is represented in the Gáj series only by *E. Jacquemonti* and the few doubtful small examples which we have referred to *E. spheroidalis*. It is true that *E. Jacquemonti* occurs in large numbers and from many different localities, to such extent as to constitute a characteristic form of the series; still when compared with the varied species in the lower strata, it is undeniable that the genus was already on the wane. *E. Jacquemonti* is nearly allied to *E. indica* from the Miocene of Kachh; and its affinities are also close to the species at present existing in the Indian Ocean.

The genus *Schizaster* is represented by two species:—*S. Granti*, which is a characteristic form in the Nari deposits and in Kattywar, is numerous; *S. sufflatus*, an allied but distinct form, is only represented by a single badly preserved example.

V. TABLE SHOWING THE DISTRIBUTION OF THE FOSSIL ECHINOIDEA IN THE TERTIARY STRATA OF WESTERN SIND, KACHH, KATTYWAR, AND THE MAKRÁN COAST*.

	Western Sind.					Kachh.			Kattywar.	Makrán Coast.
	Cardita-Beaumonti Beds.	Ranikot.	Khirthar.	Nari.	Gáj.	Nummulitic.	Oligocene.	Miocene.	Miocene.	Pliocene.
ECHINOIDEA ENDOCYCLICA.										
Cidaridæ.										
Cidaris, Klein.										
C. depressa, D. & S.	..	..	..	..	..	..	..	..	+	
C. excelsa, D. & S.	..	..	..	..	+					
C. granulata, D. & S.	..	..	..	..	..	..	..	..	+	
C. Halaensis, d'A. & H.	..	..	..	..	..	..	..	+		
C. lacrymula, D. & S.	+									
C. opipara, D. & S.	..	..	..	..	+					
C. Verneuili, d'Arch.	..	+								
C. sp. indet.	..	+								
C. sp. indet.	..	..	..	+						
C. sp. indet.	..	..	..	..	+					
C. sp. indet.	..	..	..	..	..	..	..	..	..	+
C. sp. indet.	..	..	..	..	..	..	..	..	..	+
Phyllacanthus, Brandt.										
P. Ramkoti, D. & S.	..	+								
P. Sindensis, D. & S.	..	+								
P. sp. indet.	..	+								
Leiocidaris, Desor.										
L. canaliculata, D. & S.	..	..	+							
Goniocidaris, Desor.										
G. affinis, D. & S.	..	..	..	..	..	..	..	+		
Porocidaris, Desor.										
P. anomala, D. & S.	..	..	+							
P. sp. indet.	..	+								
Saleniadæ.										
Salenia, Gray.										
S. Blanfordi, D. & S.	..	+								
Arbaciadæ.										
Cœlopleurus, Agass.										
C. equis, Agass.	..	..	..	+						
C. Forbesi, d'A. & H.	..	..	..	+	+	..	..	+	+	
C. Pratti, d'A. & H.	..	..	..	+						
C. Sindensis, D. & S.	..	..	..	..	+					

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* In order to bring the whole of the Tertiary Echinoidea of Western India, which we have described, before the reader, we have included in this synopsis, besides the Fauna of Western Sind, the forms from Kachh, Kattywar, and the Makrán Coast.

Table of Distribution (*continued*).

	Western Sind.					Kachh.			Kattywar.	Makrán Coast.
	Cardita-Beaumonti Beds.	Ranikot.	Khirthar.	Nari.	Gáj.	Nummulitic.	Oligocene.	Miocene.	Miocene.	Pliocene.
Diadematidæ.										
Cyphosoma, Agass.										
C. abnormale, D. & S.	..	+								
C. macrostoma, D. & S.	..	..	+							
C. undatum, D. & S.	..	..	+							
C. sp. indet.	..	+								
Micropsis, Cotteau.										
M. venustula, D. & S.	..	..	+							
Acanthechinus, D. & S.										
A. noduiosus, D. & S.	..	+								
Temnopleuridæ.										
Temnopleurus, Agass.										
T. simplex, D. & S.	..	..	..	..	..	..	..	..	..	+
Temnechinus, Forbes.										
T. affinis, D. & S.	..	..	..	..	+	..	..	..	+	
T. costatus, D. & S.	..	..	..	..	..	..	..	..	+	
T. Gajensis, D. & S.	..	..	..	..	+					
T. Rousseaui, d'A. & H.	..	..	+*	..	+	..	..	+	+	
T. stellulatus, D. & S.	..	..	..	..	+					
T. tuberculosus, d'Arch.	..	..	..	..	..	..	..	..	+	
Salmacis, Agass.										
S. sp. indet.	..	..	..	..	..	..	..	..	..	+
Lepidopleurus, D. & S.										
L. hemisphæricus, D. & S.	..	..	..	..	+					
L. granulatus, D. & S.	..	..	..	..	+					
Dictyopleurus, D. & S.										
D. d'Archiaci, D. & S.	..	+								
D. Haimei, D. & S.	..	+								
D. ziczac, D. & S.	..	+								
Arachniopleurus, D. & S.										
A. reticulatus, D. & S.	..	+								
A. reticulatus, var.	..	..	..	..	..	+				
Progonechinus, D. & S.										
P. eocenicus, D. & S.	..	+								
Triplechinidæ.										
Hipponoë, Gray.										
H. antiqua, D. & S.	..	..	..	..	+					
H. proavia, D. & S.	..	..	..	..	+					
Echinus, (Rond.) Linn.										
E. subcrenatus, D. & S.	..	..	..	..	+					
Grammechinus, D. & S.										
G. regularis, D. & S.	..	..	..	..	..	..	..	..	+	
Eurypneustes, D. & S.										
E. grandis, D. & S.	..	+								
Æolopneustes, D. & S.										
Æ. de Lorioli, D. & S.	..	+								

* Doubtful.

Table of Distribution (*continued*).

	Western Sind.					Kachh.			Kattywar.	Makrán Coast.
	Cardita-Beaumonti Beds.	Ranikot.	Khirthar.	Nari.	Gaj.	Nummulitic.	Oligocene.	Miocene.	Miocene.	Pliocene.
ECHINOIDEA EXOCYCLICA.										
GNATHOSTOMATA.										
Conoclypeidæ.										
Conoclypeus, Agass.										
C. alveolatus, D. & S.	..	..	+							
C. declivis, D. & S.	..	+								
C. galerus, D. & S.	..	..	+							
C. pinguis, D. & S.	..	..	+							
C. rostratus, D. & S.	..	.	+							
C. Sindensis, D. & S.	..	+								
C. sp. indet.	..	+								
Euclypeastridæ.										
Echinocyamus, Van Phels.										
E. nummuliticus, D. & S.	..	..	+							
E. nummuliticus, var. *obesus*, D. & S.	..	..	+							
E. nummuliticus, var. *oviformis*, D. & S.	..	..	+							
E. nummuliticus, var. *planus*, D. & S.	..	..	+							
E. rotundus, D. & S.	..	..	+							
Sismondia, Desor.										
S. polymorpha, D. & S.	..	..	+							
S. polymorpha, var. *sufflata*, D. & S.	..	..	..	..	..	+				
Clypeaster, Lamk.										
C. apertus, D. & S.	..	..	..	..	..	+				
C. complanatus, D. & S.	..	..	..	..	+					
C. Carteri, D. & S.	..	..	..	..	..	..	+			
C. depressus, Sow.	..	..	..	..	+	..	..	+	+	
C. Fabriensis, D. & S.	..	..	..	..	..	..	+			
C. Goirensis, D. & S.	..	..	..	..	..	..	..	+		
C. monticulifera, D. & S.	..	..	..	+						
C. pelviformis, D. & S.	.	..	..	..	+					
C. profundus, d'Arch.	..	..	..	..	+					
C. pulvinatus, D. & S.	..	..	..	..	+					
C. simplex, D. & S.	..	..	..	+						
C. Sowerbyi, D. & S.	..	..	..	.	..	..	+			
C. suffarcinatus, D. & S.	..	..	..	..	..	..	..	..	..	+
C. Waageni, D. & S.	..	..	..	..	..	..	..	+		
C. sp. indet.	..	..	..	+						
Laganum, Klein.										
L. tumidum, D. & S.	..	..	..	..	..	..	..	..	..	+
Scutellidæ.										
Echinodiscus, Breyn.										
E. auritus, Leske, var.	..	..	..	..	..	..	..	..	..	+
E. Desori, D. & S.	..	..	..	..	+	..	..	+		
E. Desori, var	..	..	..	..	+					
E. elongatus, D. & S.	..	..	..	..	+					
E. ellipticus, D. & S.	..	..	..	..	+					
E. placenta, D. & S.	..	..	..	..	+					
E. sp. indet.	..	..	..	..	+					
E. sp. indet.	..	..	..	..	+					

Table of Distribution (*continued*).

	WESTERN SIND.					KACHH.			KATTYWAR.	MAKRÁN COAST.
	Cardita-Beaumonti Beds.	Ranikot.	Khirthar.	Nari.	Gáj.	Nummulitic.	Oligocene.	Miocene.	Miocene.	Pliocene.
ATELOSTOMATA.										
CASSIDULIDÆ.										
Amblypygus, Agass.										
A. altus, D. & S.	..	..	..	..	..	+				
A. latus, D. & S.	..	..	+							
A. patellæformis, D. & S.	..	..	+							
A. pentagonalis, D. & S.	..	..	..	..	..	+				
A. subrotundus, D. & S.	..	..	+							
A. subrotundus, var. *conicus*, D. & S.	..	..	+							
A. tumidus, D. & S.	..	..	+							
Phylloclypeus, de Loriol.										
P. sp. indet.	..	+								
Plesiolampas, D. & S.										
P. elongata, D. & S.	+									
P. ovalis, D. & S.	..	+								
P. placenta, D. & S.	..	+								
P. polygonalis, D. & S.	..	+								
P. prælonga, D. & S.	..	+								
P. rostrata, D. & S.	..	+								
Eolampas, D. & S.										
E. antecursor, D. & S.	..	+								
E. excentricus, D. & S.	..	..	+							
Echinolampas, Gray.										
E. alta, D. & S.	..	..	..	..	..	+				
E. alta, var.	..	..	..	..	..	+				
E. æquivoca, D. & S.	..	..	+							
E. angustifolia, D. & S.	..	..	+							
E. Dumesi, D. & S.	..	..	..	..	..	+				
E. d'Archiaci, D. & S.	..	..	..	+						
E. difficilis, D. & S.	..	..	..	+						
E. discoideus, d'Arch.	..	..	..	+						
E. discoideus, var. *α*, D. & S.	..	..	..	+						
E. discoideus, var. *β*, D. & S.	..	..	..	+						
E. discoideus, var. *γ*, D. & S.	..	..	..	+						
E. Feddeni, D. & S.	..	..	..	..	..	+				
E. Haimei, D. & S.	..	..	..	..	..	+				
E. Indica, D. & S.	..	..	..	..	..	..	..	+		
E. insignis, D. & S.	..	..	..	..	..	+				
E. Jacquemonti, d'A. & H.	..	..	..	..	+	..	..	+		
E. juvenilis, D. & S.	..	..	+							
E. Kachensis, D. & S.	..	..	..	..	..	+				
E. lepadiformis, D. & S.	..	..	+							
E. nummulitica, D. & S.	..	..	+							
E. obesa, D. & S.	..	..	+							
E. placenta, D. & S.	..	..	..	+						
E. Rudakensis, D. & S.	..	..	..	+						
E. rotunda, D. & S.	..	..	+							
E. Sindensis, d'Arch.	..	..	+							
E. Sindensis, var. *hemisphærica*, D. & S.	..	..	+							
E. spheroidalis, d'Arch.	..	..	..	..	+	..	..	+		

Table of Distribution (*continued*).

	WESTERN SIND.					KACHH.			KATTYWAR.	MAKRÁN COAST.
	Cardita-Beaumonti Beds.	Ranikot.	Khirthar.	Nari.	Gaj.	Nummulitic.	Oligocene.	Miocene.	Miocene.	Pliocene.
Echinolampas, Gray (continued).										
E. subconica, D. & S.	..	..	+							
E. tumida, D. & S.	..	..	..	+						
E. tumida, var.	..	..	..	+						
E. Vicaryi, D. & S.	..	..	..	..	..	+				
E. Winnei, D. & S.	..	..	..	..	..	..	..	+		
E. sp. (junior)	..	..	+							
E. sp. indet.	..	..	+							
E. sp. indet.	..	..	..	..	..	+				
E. sp. indet.	..	..	..	..	..	+				
E. sp. indet.	..	..	..	..	..	..	+			
Echinanthus, Breyn.										
E. enormis, D. & S.	..	+								
E. pumilus, D. & S.	+									
E. intermedius, D. & S.	..	..	+							
Ilarionia.										
I. Sindensis, D. & S.	..	..	+							
Cassidulus, Lamk.										
C. ellipticus, D. & S.	.	+								
C. subinvaginatus, D. & S.	..	..	+							
Rhynchopygus, d'Orb.										
R. Calderi, d'A. & H.	..	+*	+							
R. pygmæus, D. & S.	..	+	+							
Eurhodia, d'A. & H.										
E. Morrisii, d'A. & H.	..	+								
Paralampas, D. & S.										
P. minor, D. & S.	..	+								
P. pileus, D. & S.	..	+								
Neocatopygus, D. & S.										
N. rotundus, D. & S.	..	+								
SPATANGIDÆ.										
Micraster, Agass.										
M. tumidus, D. & S.	..	..	+							
Hemiaster, Desor.										
H. apicalis, D. & S.	..	..	+							
H. carinatus, D. & S.	..	..	+	..	..	+				
H. decipiens, D. & S.	..	..	..	..	..	+				
H. digonus, d'Arch.	..	..	+							
H. elongatus, D. & S.	..	+								
H. nobilis, D. & S.	..	..	+							
H. sp. indet.	..	+								
H. sp. indet.	..	..	+							
H. sp. indet.	..	..	+							
H. sp. indet.	..	..	+							
H. sp. indet.	..	..	..	..	..	+				
Brissus, Klein.										
B. sp. indet.	..	..	..	..	+					
Meoma, Gray.										
M. sp. indet.	..	..	..	..	+					
Brissopsis, Agass.										
B. sufflatus, D. & S.	..	..	+							
B. sp. indet.	..	..	.	..	..	..	..	..	+	

* Doubtful.

Table of Distribution (*continued*).

	WESTERN SIND.					KACHH.			KATTYWAR.	MAKRÁN COAST.
	Cardita-Beaumonti Beds.	Ranikot.	Khirthar.	Nari.	Gáj.	Nummulitic.	Oligocene.	Miocene.	Miocene.	Pliocene.
Metalia, Gray.										
M. agariciformis, D. & S.	..	..	+							
M. depressa, D. & S.	..	..	+							
M. scutiformis, d'Arch.	..	..	+							
M. scutiformis, var. *rotunda*, D. & S.	..	..	+							
M. Sowerbyi, D'Arch.	..	+	+							
M. sp. indet.	..	..	+							
M. sp. indet.	..	..	+							
Linthia, Merian.										
L. Indica, D. & S.	..	+								
L. orientalis, D. & S.	..	..	+							
L. Sindensis, D. & S.	+									
L. sp. indet.	..	+								
Schizaster, Agass.										
S. alveolatus, D. & S.	..	+								
S. Baluchistanensis, d'A. & H.	..	..	+							
S. Baluchistanensis, var.	..	..	..	..	..	+				
S. Granti, D. & S.	..	.	..	+	+	..	..	+	+	
S. simulans, D. & S.	..	..	+							
S. sufflatus, D. & S.	..	..	..	..	+					
S. symmetricus, D. & S.	..	..	+							
S. sp. indet.	..	..	+							
Moira, A. Agass.										
M. antiqua, D. & S.	..	..	..	..	..	..	..	+		
M. primæva, D. & S.	..	..	+•							
M. sp. indet.	..	..	..	..	+					
Prenaster, Desor.										
P. oviformis, D. & S.	..	+								
Brissopatagus, Cotteau.										
B. Sindensis, D. & S.	..	..	+							
Breynia, Desor.										
B. carinata, d'A. & H.	..	..	+•	..	+	..	..	+	+	
Macropneustes, Agass.										
M. rotundus, D. & S	..	..	+							
M. speciosus, D. & S.	..	..	+							
Peripneustes, Cotteau.										
P. insignis, D. & S.	..	..	..	..	..	+				
P. sp. indet.	..	..	+							
Troschelia, D. & S.										
T. tuberculata, D. & S.	..	..	..	..	..	..	..	+		
Euspatangus, Agass.										
E. affinis, D. & S.	..	..	..	..	..	+				
E. avellana, d'A. & H.	..	..	+							
E. cordiformis, D. & S.	..	..	+							
E. patellaris, d'A. & H.	..	..	..	..	..	..	..	+	+	
E. rostratus, d'Arch.	..	..	+	+	..	+	+			
Genus indet. (? new)	..	..	+							

• Doubtful.

VI. GENERAL INDEX OF GENERA AND SPECIES.

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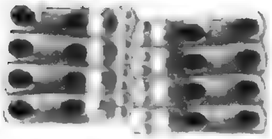
PLATE XLIV.

Figure 1. **Cidaris opipara**, Duncan and Sladen (page 279). Abactinal view of the test, natural size.
2. Profile view of the same test, natural size.
3. Actinal view of a smaller specimen, natural size.
4. Ambulacral plates near the ambitus, from the same specimen as Fig. 1, magnified.
5. Ambulacral plates on the abactinal part of the area, from the same specimen, magnified.
6. Interambulacral plate, from the same specimen, magnified.
7. Portion of an ambulacral area, to show the flexure and the posture of the plates, from the same specimen as Fig. 3, magnified. (Inadvertently placed upside down by the artist.)
8. Portion of the margin of the peristome, from the same specimen, magnified.
9. **Cidaris excelsa**, Duncan and Sladen (page 282). Interambulacral plate, magnified.
10. Ambulacral plates, magnified.
11. A fragment of the test, natural size.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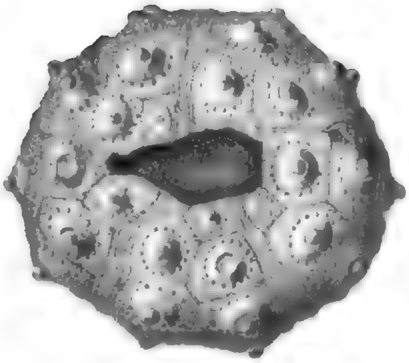
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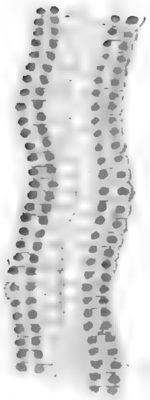
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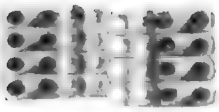
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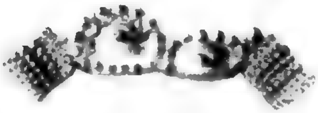
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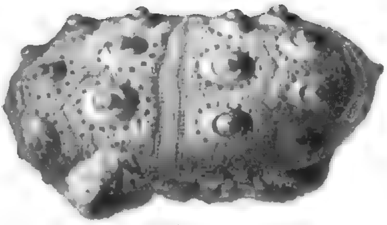
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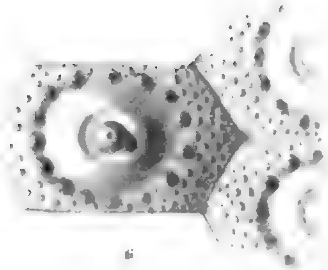
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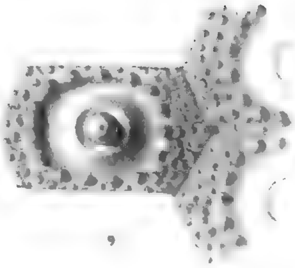
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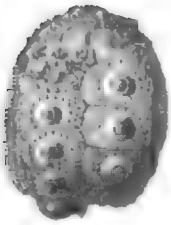
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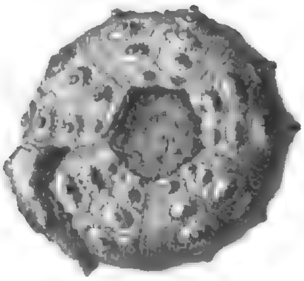
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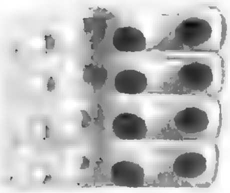
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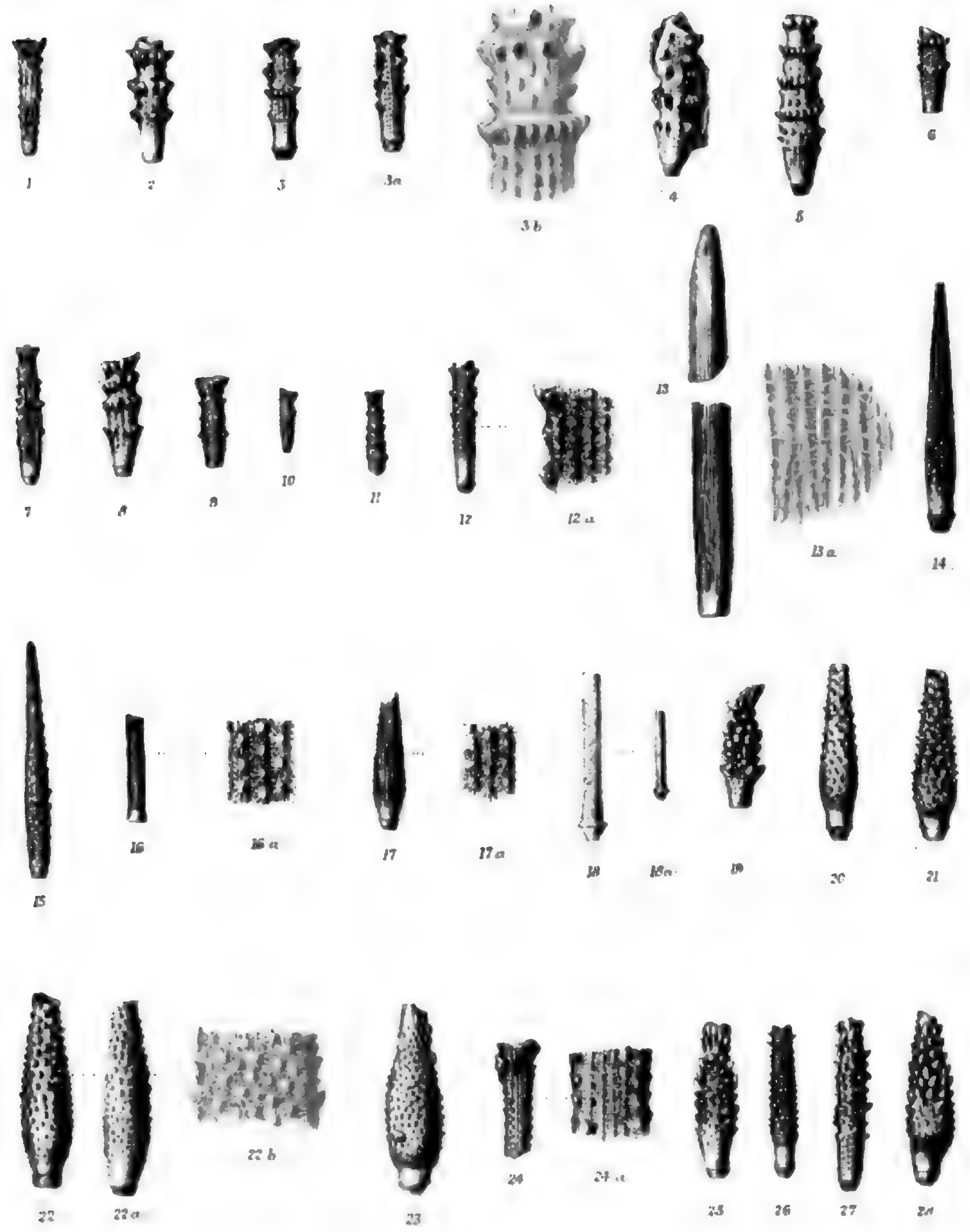
Fossil Echinoidea from Sind.
(Gaj Series. Miocene.)

PLATE XLV.

Figures 1–17 and 19–28. Detached spines of several species of Cidaris (page 283).
18. Spine of an unknown species (page 285).

Each spine is drawn natural size: the reverse side and a magnified portion being also given in some cases.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3a
3b
4
5
6
7
8
9
10
11
12
12 a
13
13 a
14
15
16
16 a
17
17 a
18
18a
19
20
21
22
22 a
22 b
23
24
24 a
25
26
27
28

Duncan & Sladen del. A. [illegible]

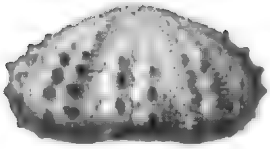
Mintern Bros. imp.

Fossil Echinoidea from Sind.

Gaj Series Miocene

PLATE XLVI.

Figure 1. Cœlopleurus Forbesi, d'Archiac (page 287).
2. Another specimen.
3. Cœlopleurus Sindensis, Duncan and Sladen (page 298).
4. Cœlopleurus Forbesi. A small specimen (page 295).
5. Cœlopleurus Sindensis. A more tumid form.
6. The apical disk of a small specimen, magnified.
7. Cœlopleurus Forbesi. An ambulacrum, abactinal part, magnified, showing the sutures fairly well.
8. Cœlopleurus Sindensis. Part of an interradium near the apical system, magnified.
9. Cœlopleurus Forbesi. The peristomial part of an ambulacrum, showing the "Tags," magnified. (The artist has placed, by mistake, two pores actinally to one of the ambulacral tubercles.)
10. Cœlopleurus Sindensis. Part of an ambulacrum, magnified.



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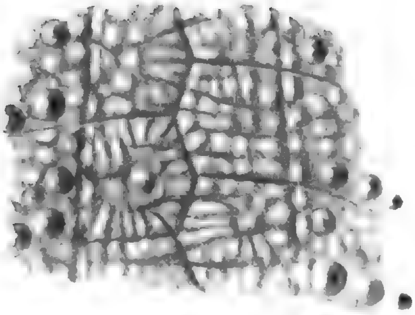

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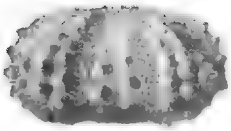

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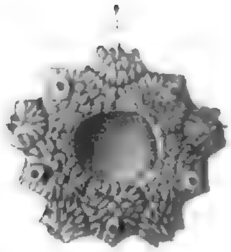

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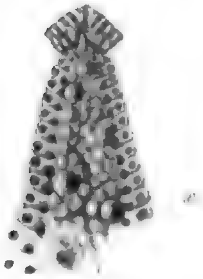

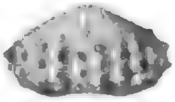

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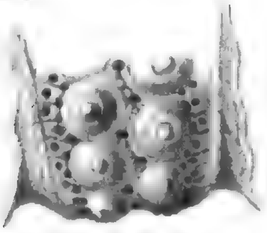

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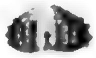

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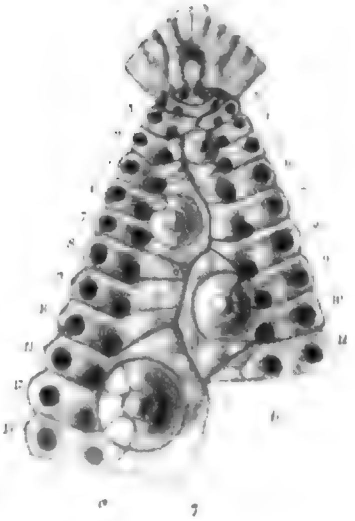

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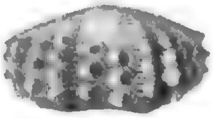

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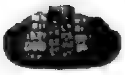
Fossil Echinoidea from Sind.
(Gaj series. Miocene.)

PLATE XLVII.

Figure 1. Cœlopleurus Sindensis, Duncan and Sladen (page 298).
2. An apical plate, the radial III., magnified.
3. Temnechinus Rousseaui, d'Archiac (page 303). The test, natural size.
4. The interradium and ambulacrum near the peristome, magnified, showing the structure of the ambulacral plates.
5. Lepidopleurus hemisphæricus, Duncan and Sladen (page 306).
6. The apical system and part of the test, magnified.
7. Part of the test near the ambitus, magnified.
8. Temnechinus stellulatus, Duncan and Sladen (page 304).
9. Part of the side of the test, magnified.
10. Temnechinus Gajensis, Duncan and Sladen (page 305). A test.
11. Part of the test, magnified.
12. Temnechinus Rousseaui, d'Archiac. A plate and part of an ambulacrum, magnified.



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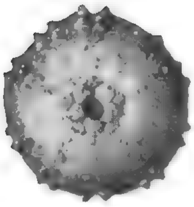

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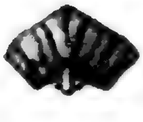

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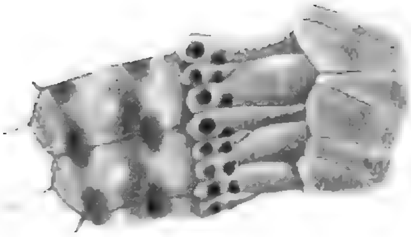

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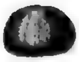

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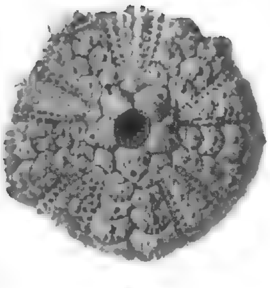

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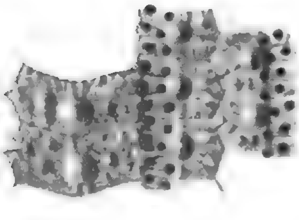

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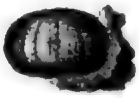

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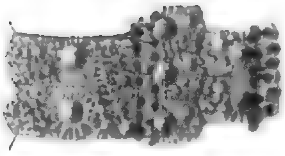

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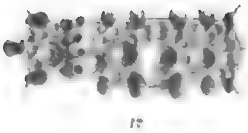

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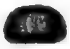

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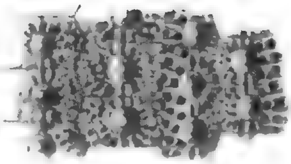

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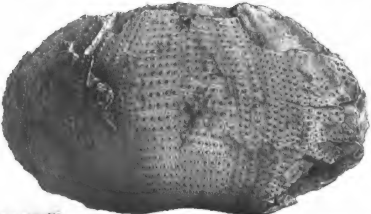
Fossil Echinoidea from Sind.
(Gaj Series – Miocene.)

PLATE XLVIII.

Figure 1. HIPPONOË PROAVIA, Duncan and Sladen (page 310). Profile view of the test, natural size.

2. Actinal view of the same, natural size.
3. Interradial plates, to show ornamentation, magnified.
4. Part of the ambulacral area, to show the composition of the plates, magnified.

4 *a*. Diagrammatic sketch of ambulacral plates, to show the disposition of the ornamentation, magnified.



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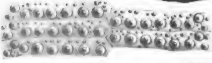

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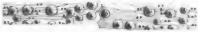

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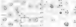

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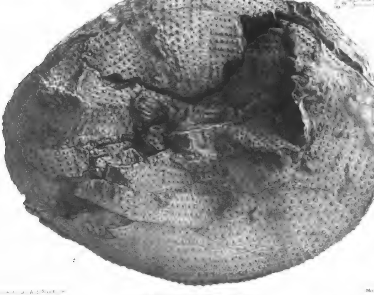

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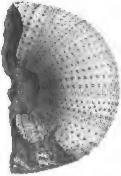
Mintern Bros imp.

Fossil Echinoidea from Sind.
(Gaj Series – Miocene.)

PLATE XLIX.

Figure 1. HIPPONOË PROAVIA, Duncan and Sladen (page 310). Fragment of a small test, probably belonging to this species, natural size.

2. HIPPONOË ANTIQUA, Duncan and Sladen (page 313). Abactinal view of the test, natural size.
3. Actinal view of a smaller specimen, natural size.
4. Profile view of the same fragment, natural size.
5. ECHINUS SUBCRENATUS, Duncan and Sladen (page 317). Abactinal view of the test, natural size.
6. Ambulacral and interambulacral plates, a little above the ambitus, magnified.
7. SCHIZASTER SUFFLATUS, Duncan and Sladen (page 339). Abactinal view of the test, natural size.
8. Longitudinal profile of the test, natural size.
9. Ambulacral plates in the odd anterior ambulacrum, magnified.



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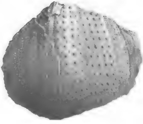

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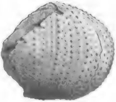

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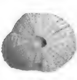

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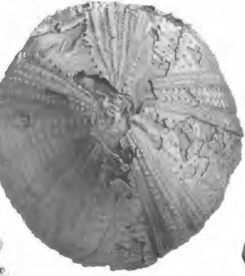

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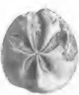

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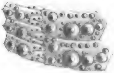

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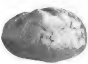

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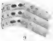

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Duncan & Sladen dir. A. S. Foord lith.

Mintern Bros. imp.

Fossil Echinoidea from Sind.

(Gaj Series—Miocene.)

PLATE L.

Figure 1. Clypeaster profundus (d'Archiac), Duncan and Sladen (page 319). Abactinal view of the test, natural size.

2. Longitudinal profile of the same, natural size.

3. An ambulacral petal, magnified.

4. Ornamentation of the interradial plates on the abactinal surface, magnified.

5. Clypeaster pulvinatus, Duncan and Sladen (page 322). Abactinal view of the test, natural size.

6. Longitudinal profile of the same, natural size.

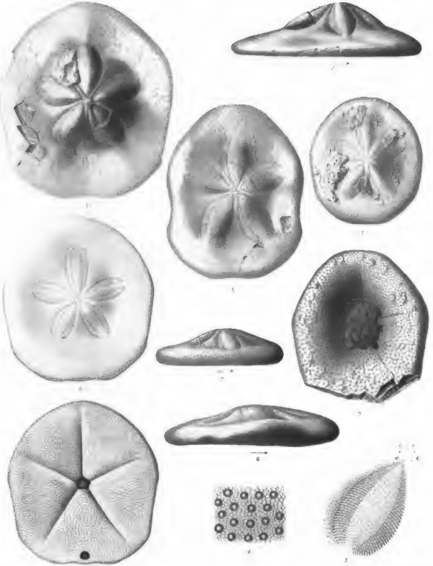
7. Clypeaster pelviformis, Duncan and Sladen (page 324). Abactinal view of a small test, natural size.

8. Longitudinal profile of the same, natural size.

9. Actinal view of a larger test, natural size.

10. Clypeaster complanatus, Duncan and Sladen (page 325). Abactinal view of the test, natural size.

11. Actinal view of the same, natural size.

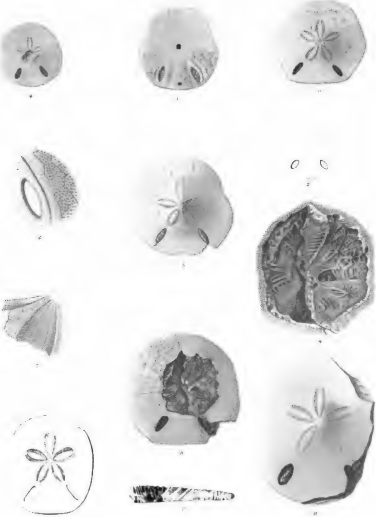


Mintern Bros. imp.

Fossil Echinoidea from Sind.

PLATE LI.

Figure 1. Echinodiscus Desori, Duncan and Sladen (page 328). Actinal view, natural size.
2. An outline of a test of the same species.
3. A variety of the species, abactinal view.
4. Abactinal view of another variety (page 328).
5. Abactinal view of the same variety.
6. A magnified view of the lunule from below.
7. Echinodiscus placenta, Duncan and Sladen (page 329). Portion of an inter-radium and ambulacra, slightly magnified.
8. Echinodiscus Desori. Broken test, showing the crushed jaws from above, and some of the supporting structures between the upper and lower parts of the test.
9. Part of the same, magnified.
10. Echinodiscus elongatus, Duncan and Sladen (page 331). The test in outline, natural size.
11. Echinodiscus ellipticus, Duncan and Sladen (page 330). The test, natural size.
12. Echinodiscus Desori, var. Side view of a portion of a test, showing the plates and pillars in section.

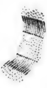


Fossil Echinoidea from Sind

PLATE LII.

Figure 1. Echinodiscus placenta, Duncan and Sladen (page 329). Abactinal view, natural size.

2. The apical disk, magnified.
3. Part of an ambulacrum, magnified.
4. Echinodiscus, sp. (page 331). Part of the test, abactinal view, natural size.
5. Actinal view of the same specimen.
6. Part of the same magnified, showing the ambulacra near the peristome.
7. Surface of a test, showing the tops of the supporting structures.
8. Echinodiscus placenta, Duncan and Sladen. A portion of an ambulacrum and lunule, slightly magnified.



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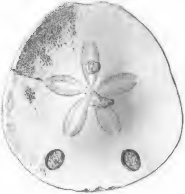

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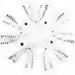

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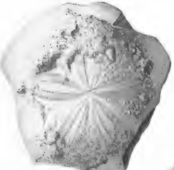

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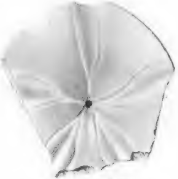

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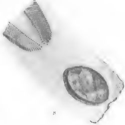

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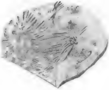

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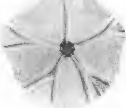

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Duncan & Sladen del. A. Gawan lith.

Mintern Bros. imp.

Fossil Echinoidea from Sind.

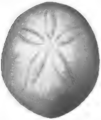
(Gaj Series. Miocene.)

PLATE LIII.

Figure 1. **Echinolampas Jacquemonti**, d'Archiac and Haime (page 337). Abactinal view of a regularly convex, subdepressed form, natural size.

2. Longitudinal profile of the same, natural size.
3. Abactinal view of a high, subconical, and rather elongate form, natural size.
4. Longitudinal profile of the same, natural size.
5. Actinal view of the same, natural size.
6. Abactinal view of a broad-petalled variety, natural size.
7. The peristome and surrounding parts of the test, magnified.
8. Abactinal view of a small subrotund test, natural size.
9. Longitudinal profile of the same, natural size.
10. Actinal view of the same, natural size.
11. The peristome and surrounding parts, from the same specimen, magnified.
12. Portion of an ambulacral petal, to show the ornamentation, magnified.
13. Actinal view of a small tumid test, natural size.
14. Longitudinal profile of the same, natural size.
15. **Echinolampas spheroidalis**?, d'Archiac (page 338). Actinal view of the test of the largest specimen, natural size.
16. Abactinal view of another specimen, much crushed and weathered, natural size.
17. Longitudinal profile of the same specimen as Fig. 15, natural size.
18. Actinal view of a small specimen, natural size.
19. Longitudinal profile of the same, natural size.

Erratum in the lettering of the Plate:—For Fig. "12" (adjacent to Fig. 19) read "18."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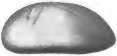
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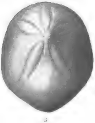
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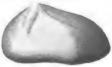
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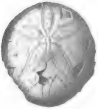
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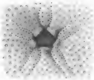
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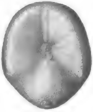
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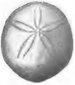
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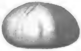
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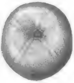
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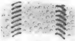
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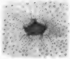
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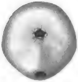
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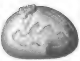
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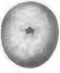
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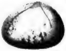
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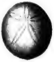
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Duncan & Sladen, del. A. Swaine lith.

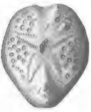
Mintern Bros. imp.

Fossil Echinoidea from Sind.

Gaj Series - Miocene.

PLATE LIV.

Figures 1–9. **Breynia carinata**, d'Archiac and Haime (page 343). Abactinal views of various specimens. Fig. 5 is the normal form.



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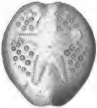

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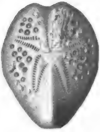

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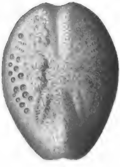

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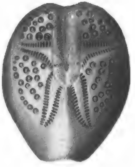

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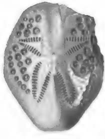

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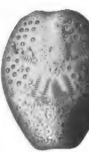

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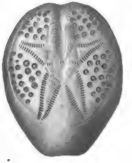

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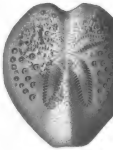

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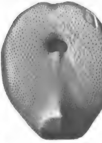
Dunlop & Hademacher A. Swain, lith.

Mintern Bros. imp.

Fossil Echinoidea from Sind.
(Gaj Series Miocene.)

PLATE LV.

Figure 1. **Breynia carinata**, d'Archiac and Haime (page 343). Actinal view.
2. The test, side view.
3. The posterior view, with the subanal fasciole.
4. The apical system, the internal fasciole, and the ambulacra within the fasciole, magnified.
5. The peristomial area, showing the floscelle, the interradia coming to the oral margin, the wide posterior ambulacra, and the long and narrow plate of the posterior interradium, magnified.
6. A tubercle of the actinal surface, magnified.
7. A tubercle of the same region, showing the hypertrophy of the crenulation on one side, magnified.
8. A tubercle in its sunken scrobicule, from the abactinal surface, magnified.
9. **Brissus**, sp. (page 354). Actinal surface, natural size.



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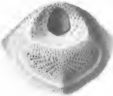

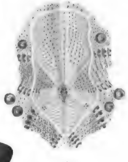

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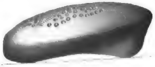

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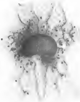

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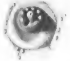

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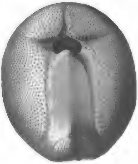

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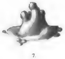
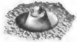


7



8

Mintern Bros. imp.

Dun.. & Sucier. del. A. Haver. lith.

Fossil Echinoidea from Sind.
(Gaj Series. Miocene.)

MEMOIRS

OF THE

GEOLOGICAL SURVEY OF INDIA.

Palæontologia Indica,

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING
THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL.

Ser. XIV. Vol. I. 3.

FOSSIL ECHINOIDEA OF WESTERN SIND AND THE COAST OF BILÚCHÍSTÁN AND OF THE PERSIAN GULF, FROM THE TERTIARY FORMATIONS.

BY

P. MARTIN DUNCAN, M.B. (LOND.), F.R.S., F.G.S., F.L.S.,

AND

W. PERCY SLADEN, F.G.S., F.L.S., &c.

Fasc. i, 1882.—ECHINOIDEA FROM BENEATH THE TRAP IN WESTERN SIND.
Fasc. ii, 1882.—ECHINOIDEA FROM THE RANIKOT SERIES OF WESTERN SIND.
Fasc. iii, 1884.—ECHINOIDEA FROM THE KHIRTHAR SERIES OF WESTERN SIND.
Fasc. iv, 1884.—ECHINOIDEA FROM THE NARI SERIES OF WESTERN SIND.
Fasc. v, 1885.—ECHINOIDEA FROM THE GÁJ SERIES OF WESTERN SIND.
Fasc. vi, 1886.—ECHINOIDEA FROM THE MAKRÁN SERIES OF THE COAST OF BILÚCHÍSTÁN AND OF THE PERSIAN GULF.

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TERTIARY AND UPPER CRETACEOUS FOSSILS OF WESTERN SIND.

Ser. XIV.

Vol. I. 3. THE FOSSIL ECHINOIDEA.

Fasciculus VI. THE FOSSIL ECHINOIDEA FROM THE MAKRÁN SERIES (PLIOCENE) OF THE COAST OF BILÚCHÍSTÁN AND OF THE PERSIAN GULF.

[*A Supplementary Part to the* MONOGRAPHS OF THE FOSSIL ECHINOIDEA OF SIND.]

WITH 3 PLATES.

BY

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AND

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PREFACE.

The Echinoidea hitherto described by us belong to well-defined horizons of the Tertiary deposits. We have described the species of Echinoidea from the beds with *Cardita Beaumonti*, which belong to the lowest Eocene, and also from an important series, the Ranikot, which is below the true Nummulitic limestone. The Nummulitic limestone yielded the fauna of Echinoidea which has been studied as belonging to the Khirthar deposits, and we have considered the Oligocene Echinoidea or those belonging to the Nari strata. The Miocene Echinoidea of the Gáj series have been studied. The Echinoidea of Kachh and Kattywar have also been described in succession. But in Sind and in the two provinces just mentioned there are no marine Pliocene deposits. There are, however, Pliocene marine deposits on the coast of Bilúchístán and on islands in the Persian Gulf, and the specimens of Echinoidea collected there were kindly submitted to us for examination by H. B. Medlicott, F.R.S., the Superintendent of the Geological Survey of India. The collection was made by W. T. Blanford, F.R.S. They are described in this supplementary Part, and thus we present descriptions of the Echinoidea of a vast unbroken succession of Tertiary strata.

It will be noticed in the preceding Part, which referred to the Gáj series, that we add the species of the Pliocene deposits to the others in the Tables, and that there is the same marked difference between the Pliocene fauna and the Miocene as there is between the other consecutive deposits. This Part closes our work on the Echinoidea of the Tertiaries of Western India.

LONDON, December 1885.

A DESCRIPTION

OF THE

FOSSIL ECHINOIDEA

OF THE

COAST OF BILÚCHÍSTÁN

AND OF

SOME ISLANDS IN THE PERSIAN GULF.

THE MAKRÁN SERIES (PLIOCENE).

PLATES LVI.–LVIII.

I. *Introductory Remarks.*

WE owe the description of the geology of the coast of Bilúchístán, or, as it is more commonly called, the Makrán coast, and the collection of fossils, to Mr. W. T. **Blanford**, F.R.S., who, whilst Deputy Superintendent of the Geological Survey of India, surveyed the littoral tracts of Bilúchístán and the coast of Persia[*]. He stated[†] that "the prevailing rock along the Makrán coast is a pale grey clay more or less indurated, occasionally intersected by veins of gypsum, usually sandy and often calcareous, occurring in beds of great thickness. With this clay are interstratified bands of shelly limestone, calcareous grit, and sandstone, but these usually form but a small portion of the mass, although their greater hardness makes them conspicuous at the surface.

"In all sea-cliffs and inland scarps the clay is well exposed: thus the magnificent cliff, nearly 2000 feet high, at Rás Malán is almost entirely composed of it. From its softness it disintegrates rapidly and the usual features of the scenery are peculiar and characteristic." Sometimes the clayey and calcareous strata are more or less horizontal and at others they dip at considerable angles, and as the clay wears more rapidly than the other constituents of the mass, the position of the strata determines flat-topped hills and a very serrated appearance in the inclined beds. The Makrán beds are evidently of marine origin. They are usually highly fossiliferous, the most abundant fossils being species of *Ostrea*, *Pecten*, and *Balanus*. *Arca*, *Cardium*, *Lucina*, and species of the family of *Veneridæ* abound, but very often only occur as casts. Gasteropoda, though far from scarce, are less common—forms of *Cerithium*, *Turritella*, and *Natica* being perhaps the most prevalent. *Operculina* is noticed as the common genus of Foraminifera. Blanford noticed that the fauna differed from that of the Nummulitic rocks and that several of the fossils appeared to be identical with forms now living in the neighbouring seas. Subsequently, in the 'Manual of the Geology of India,' p. 470, he showed that the Makrán group was probably a marine representative of the Siwalik or Manchhar beds of Sind and northern India. Some of the Makrán beds were upheaved at least 2000 feet after the close of their deposition, and the upheaval progressed during the formation of the Littoral concrete.

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[*] Records of the Geol. Survey of India, vol. v. 1872, pt. 2, p. 41.

[†] Page 43.

The other localities where this formation is seen and where Echinoidea have been found are Henjam Island and Khárak Island, in the Persian Gulf. Although there can be little doubt that the rocks at both these localities belong to the same series as those of the Makrán coast, the precise horizon may be slightly different, perhaps rather higher.

So far as the Echinodermata are concerned, no older Tertiary species are found in the Makrán beds, and the Gáj fauna of Sind and of Kachh and Kattywar has but one doubtful representative in them *. The facies is more recent than Miocene, most of the species being closely allied to recent forms, and the genera are all represented in the Asiatic and Australian seas.

The deposit in which the Echinoidea were collected was a shallow-water one, and most of the specimens are broken, and many are imbedded in a sandy matrix full of comminuted shallow-water shells.

The forms of Echinoidea which were collected and sent to us by the Geological Survey of India are all generically, but not always specifically, determinable, and we have carefully avoided giving a specific name to imperfect specimens.

II. *List of the Fossil Echinoidea of the Makrán Series.*

Order ECHINOIDEA ENDOCYCLICA.

Family CIDARIDÆ.

Genus Cidaris, *Klein*, 1734.

Cidaris, sp. (Goniocidaris ?): p. 372.
——, sp.: p. 373.

---

* One of the Cidaridæ is possibly common to the deposits.

Family TEMNOPLEURIDÆ.

Genus SALMACIS, *Agassiz*, 1841.

Salmacis, sp.: p. 374.

Genus TEMNOPLEURUS, *Agassiz*, 1841.

Temnopleurus simplex, *Duncan & Sladen*: p. 375.

Order ECHINOIDEA EXOCYCLICA.

Suborder GNATHOSTOMATA.

Family CLYPEASTRIDÆ.

Subfamily EUCLYPEASTRINÆ.

Genus CLYPEASTER, *Lamarck*, 1801.

Clypeaster suffarcinatus, *Duncan & Sladen*: p. 376.

Subfamily LAGANINÆ.

Genus LAGANUM, *Klein*, 1734.

Laganum tumidum, *Duncan & Sladen*: p. 379.

Family SCUTELLIDÆ.

Genus ECHINODISCUS, *Breyn.*, emend.

Echinodiscus auritus, *Leske*, a variety: p. 381.

Suborder ATELOSTOMATA.

Family SPATANGIDÆ.

Subfamily SPATANGINÆ.

Genus SCHIZASTER, *Agassiz*, 1836.

Schizaster, sp.: p. 381.

Genus BREYNIA, *Desor*, 1847.

Breynia, sp.?, young: p. 381.

List of the determined Species.

1. Temnopleurus simplex, *Duncan & Sladen*: p. 375.
2. Clypeaster suffarcinatus, *Duncan & Sladen*: p. 376.
3. Laganum tumidum, *Duncan & Sladen*: p. 379.
4. Echinodiscus auritus, *Leske*, var.: p. 381.

List of Forms not identified.

1. Cidaris, sp. (Goniocidaris?): p. 372.
2. ——, sp.: p. 373.
3. Salmacis, sp.: p. 374.
4. Schizaster, sp.: p. 381.
5. Breynia? sp.: p. 381.

III. *Description of the Species of Echinoidea.*

Order ECHINOIDEA ENDOCYCLICA.

Family CIDARIDÆ.

Genus CIDARIS, *Klein*, 1734.

1. Cidaris, sp. (Goniocidaris?). Plate LVI, Figs. 1 & 2.

Several well-preserved fragments of a species of *Cidaris* are in the collection from the Makrán beds; but there is not sufficient material to give a specific character, and indeed the generic position is doubtful.

Test tall; ambulacra wide and very slightly flexuous, with ten pairs of pores in relation to a coronal plate at the ambitus.

Interporiferous part of the ambulacral plates as wide as the poriferous zone, but it is low and ornamented with a small secondary tubercle close to the poriferous zone and with three small granules, two of which are usually in a line and nearer the adoral margin of the plate than the aboral. Sometimes there is a small tubercle placed aborally to the second tubercle. The small secondary is in continuation with the ridge which separates the pairs of pores. The adoral pore is usually the larger of the two, and there is a distinct and broad partition, convex from above downwards, between the pores of a pair.

The interradial plates are broader than high, the height diminishing towards the peristome, and the elliptical shape of the scrobicules increases from the ambitus in both directions. The slope of the coronal plates to the median suture of the interradium is decided, and there is some sinking at the suture. Sometimes there is a distinct sutural groove between the successive coronal plates. The scrobicular margins are perfect, and are surrounded by a row of small secondaries with rounded mamelons, and usually they are small actinally and abactinally to the scrobicule and separated all round the circle by large granules. The boss is low and has a wide grooved collar; the mamelon is hemispherical and has a wide neck. There is perforation but not crenulation. There is some sinking of the plates within the raised scrobicular margin. Between the scrobicular circle and the poriferous zone, there is a small row of secondaries close to the larger series and also some granules, and on the other side at least three rows of granules are developed between the circle and the sunken median suture, and on a rather tumid and sloping part of the plates.

Locality. Henjam Island, Persian Gulf. Makrán deposits. Survey-number G $\frac{292}{5}$.

Illustrations of the Specimen in Plate LVI.

Fig. 1. A part of a test: natural size.
2. Ambulacral plates: magnified.

This is the form of *Cidaris* which approaches *Goniocidaris*, and was noticed in the Description of the Fossil Echinoidea of Kachh and Kattywar, one of which appears to be a true *Goniocidaris* ("Tert. Foss. Echin. Kachh and Kattywar," Pal. Ind. Ser. XIV. 1883, p. 52).

The broad median area, moderately crowded with very small tubercles and granules, is very distinctive; but there is much variation in regard to the amount of sinking and doubtful pitting at the angles of the median suture. In a fragment of a large individual there is barely any sinking whatever, and nothing to raise doubts about the form being a *Cidaris*, except the broad interporiferous zone. On the other hand a slightly smaller form, which approaches the type very closely, has great affinities with *Goniocidaris*.

The numerous spines which come from the same locality as these fragments are all more like those of recent species of *Goniocidaris* than of *Cidaris*.

2. CIDARIS, sp. Plate LVI, Fig. 3.

There is a well-preserved fragment of a small *Cidaris*, which although having affinities with the species just described, is to be distinguished by the absence of the well-developed slope of the coronal plates, from the ring of small tubercles around the scrobicular margin to the median line. In the species noticed above this surface is covered with at least three rows of differently developed granules; but in the present instance the rows are wanting, and the tubercles around the elliptical scrobicular circle have a row of large granules on a narrow surface between them and the well-indented vertical sutures. Moreover, the line of secondary tubercles between the successive vertical tubercles is sometimes absent and the scrobicules are continuous, or there is but one, and not a very well-developed, row of secondaries in that position.

The interporiferous part of an ambulacral plate is narrower than the poriferous portion, and carries a small tubercle close to the adoral pore; beyond is a smaller one, and near the ambitus there may be one or two granules between the last-mentioned tubercle and the median line.

Locality. Henjam Island, Persian Gulf. Makrán deposits. Survey-number G $\frac{381}{3}$.

Illustration of the Specimen in Plate LVI.

Fig. 3. Coronal plates: magnified.

SPINES OF CIDARIDÆ. Plate LVII.

Spines of species of more than one genus of the family Cidaridæ are common in the white calcareous deposit, and they are not found in quite a perfect condition, for the tops of the spinules on them are broken off. Most of the spines are short, large, and more or less compressed, and they may be grouped into three sets.

1. Spines not very tall, cylindrical, irregularly and strongly spinulose, expanding slightly at the summit, where there is a shallow hollow surrounded with spinules.

One side of the spine is granulated and free from spinules, and the other has them and also faint granulation. Figs. 1, 2, & 14.

2. Tall compressed spines more or less wedge-shaped, with a considerable expansion at the summit where the hollowing is considerable, and the crown of spinules is large. Granules only on one side of the spine, and spinules on the other. Figs. 3 to 9 and 12 & 13.

3. Short narrow-based spines which expand suddenly, and have a wide and deep hollow at the summit surrounded by long spinules. Granulation distinct on one side of the spine. Figs. 10 & 11.

In all these forms the articular facette is smooth and small for the size of the spines; there is a slight ring to the cylindrical bouton, which is usually crenulated on one side. The collerette is smooth and pronounced.

Late researches by A. Agassiz have shown that there is a much greater diversity of spines in the same species than was formerly acknowledged, and it is therefore not safe to name forms from the characters of their spines only. Nevertheless, the resemblance of the spines figured by us to some of those already noticed in describing the Fossil Echinoidea of Kachh and Kattywar is unquestionable; and they are found in deposits with a *Goniocidaris* [*]. The similarity of some of the spines to those of *Goniocidaris* drawn by A. Agassiz in the "Challenger Echinoidea" is very close [†].

Locality. Henjam Island, Persian Gulf. Makrán deposits. Survey-number G 2§2.

Family TEMNOPLEURIDÆ.

Genus SALMACIS, *Agassiz*, 1841.

1. Salmacis, sp. Plate LVI, Fig. 4.

Fragments of a test of an undescribed species of *Salmacis* occur, which is characterized by the presence of three vertical rows of tubercles on each part of the interradia on either side of the median line, at and below the ambitus. There are small secondaries on the coronal plate close to the poriferous zones. There are two rows of large tubercles within the ambulacra; they are separated by low granules, and there is a small secondary on the angle of each plate near the median line. The cuts are small.

The form is more closely allied to *Salmacis Dussumieri*, Agass., than to *Salmacis bicolor*, Agass.

Locality. Makrán coast deposits. Survey-number?

Illustration of the Specimen in Plate LVI.

Fig. 4. Part of the test: magnified.

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[*] Pal. Ind. Ser. XIV. 1883, pl. viii, figs. 9–14.

[†] 'Report on the Echinoidea of the Challenger Expedition,' plate i.

Genus TEMNOPLEURUS, *Agassiz*, 1841.

The distinctions between this genus and *Temnechinus*, Forbes, have been considered on a former page in criticizing the zoological position of the forms which were included in *Temnopleurus* by d'Archiac and Haime (Part ii, page 36). There is no doubt that a fossil *Temnopleurus* occurs in the Indian Tertiaries, for there are numerous parts of tests of a species of the genus in the Makrán deposits. Unfortunately the apical system is wanting in all; but the peristome and the ornamentation, which give good specific distinctions, are present. The species is not without its affinities with *Salmacis*.

1. TEMNOPLEURUS SIMPLEX, *Duncan & Sladen*. Plate LVI, Figs. 5–7.

The test is broader than high, broadest at the ambitus, which is situated close to the resting base, depressed and conical abactinally, tumid at the margin. Actinally rather tumid, and sloping upwards around the very small and slightly cut peristome. Ambulacra narrow. The pairs of pores are in simple series, there are three pairs to each plate, and they are separated by well-developed convex-topped costæ which terminate either in small tubercles or in granules. The pores are on the actinal surface of the costal ridges. The arrangement of the three pairs of pores to each plate is slightly pronounced, and there is barely a trace of a curving. The ambulacral plates are broader than high, and each has a primary tubercle which is crenulate and imperforate, and is surrounded by a circle of granules, there being also a small secondary at the aboral angle near the pores. The pits at the angles of the plates are small and the furrows over the transverse sutures are small, or they may be absent in young forms.

The interradial plates have only one tubercle on each, but there is sometimes a secondary at the inner angle as well as at the poriferous side, and a ring of granules surrounds the primary and separates it from the secondaries. The shape and size of the interradial and ambulacral tubercles is much the same.

There are numerous small granules and very small secondaries at the median line, and the surface is depressed there near the apex. Median furrow distinct, but the pits and furrows in relation to the transverse sutures are slight. With growth, the larger specimens have a barer median area and more distinct pits.

Dimensions. Breadth 25, 19, and 18 millim.; 13 and 10 millim. high. Peristome only 5·5 millim. broad.

Locality. Ras Malán, Makrán coast. Survey-number G $\frac{362}{11}$.

Illustrations of the Species in Plate LVI.

Fig. 5. The test: natural size.
6. Part of the test near the peristome: magnified.
7. Ambulacral plate: magnified.

Order **ECHINOIDEA EXOCYCLICA.**

Suborder GNATHOSTOMATA.

Family CLYPEASTRIDÆ.

Subfamily EUCLYPEASTRINÆ.

Genus CLYPEASTER, *Lamarck*, 1801.

1. Clypeaster suffarcinatus, *Duncan & Sladen*. Plate LVIII, Figs. 1–5.

Marginal contour subpentagonal, with the angles full and well rounded, their prominence being emphasized by a well-defined reentering curvature in the paired interradia, the lateral being the deepest; the odd posterior interradium is usually truncate, though in some examples slightly reentering. The contour is thus remarkably undulating, and is subject to considerable variation. The length is greater than the breadth in the proportion of 1 : 0·872; and the greatest breadth is opposite the extremity of the antero-lateral petals; the breadth across the test opposite the extremity of the postero-lateral petals is distinctly smaller, and the intervening area of the margin is deeply incurved. The margin is thin and rounded, thicker anteriorly than elsewhere, but shows scarcely any undulation, in consequence of the generally level character of the abactinal surface between the margin and the area of the petals. The abactinal surface passes from the margin with a gentle slope, having a very small angle of declivity until it reaches the area of the petals, where it rises rather abruptly at a steeper angle to form a convex dome, which comprises the whole region of the petals. Seen in longitudinal profile the posterior declivity of the dome is more rapid than the anterior, and whilst a portion of the test from the dome to the margin forms a gentle slope posteriorly, it is nearly level and subtumid anteriorly. The summit of the dome appears in this view slightly truncate, and this truncate area slopes slightly to the front, the greatest height of the test being excentral and situated at a little distance behind the apical disk.

The apical disk is subcentral. The ambulacral petals are moderately long, wide, petaloid, elliptically ovate in outline, completely closed at the outer extremity, and more or less tumid, sometimes prominently so. The odd anterior and the postero-lateral ambulacra are of equal length, and longer than the antero-lateral pair. All are subequal in width. The greatest width of the paired petals lies a little further outward than midway between the extremities of the petal, and is very nearly half the length, the actual dimensions of the postero-lateral petal in the specimen under description being 30 millim. long, and its greatest breadth 14·5 millim. The poriferous zones are wide, increasing gradually from the apex up to the commencement of the outer third, where the maximum breadth is reached; they then decrease slowly and gradually to the extremity, where they are still wide; the two zones of a petal trending towards one another with a well-rounded curvature, until they meet and completely close the outer extremity of the petal, the outer series of pores marking a well-defined, rounded, but slightly elliptical, outline at the end of the petal. The inner pores are round, and the outer pores are often very slightly oval or subpyriform; they are united by a distinct, but very shallow, conjugating furrow, and the broad intermediate costæ are ornamented with a row of 3–5 small scrobiculated tubercles rather widely spaced, and with small intervening granules in serial line. The broadest part of the poriferous zone is 3·5 millim., and is very little wider than one third the interporiferous area at that place. The widest part of the interporiferous area is at the same place, and measures 9 millim. in the postero-lateral petals, and a trifle less in the anterior pair. The odd anterior petal has a rather fuller and more rounded appearance at the extremity than the others, in consequence of maintaining its greatest breadth undiminished rather further outwards than is the case in the paired petals. The distance of the antero-lateral petals from the margin is rather more than half their length, and that of the postero-lateral pair slightly greater; and the distance of the odd anterior is greater than that of the anterior pair, but less than that of the posterior pair.

The interradial areas are narrow and band-like towards the apex, in consequence of the size of the petals. The ornamentation of the interradia on the outer part consists of very small primary scrobiculated tubercles, widely spaced, with the smallest interspaces distinctly greater than the diameter of the scrobicules, and others not unfrequently twice as great or even more. The interspaces are ornamented with very minute and very widely spaced miliary granules, which have the appearance of standing on a level surface. The ornamentation of the interporiferous areas is much more crowded in every respect, and has consequently an altogether different facies, the elements of its composition being, however, the same as those just noticed. On the actinal surface the primary scrobiculated tubercles are larger along the median area of the interradia, and are widely spaced there. The tubercles diminish greatly in size along the margins of the deep ambulacral furrows.

The actinal surface is subplane, and rather abruptly depressed subcentrally to form a moderately deep, but not widely extending cavity, in which the peristome is situated; the interradia at the brink of the concavity having a puffed up or pulvinate appearance, which is further emphasized by the deep but narrow furrows of the ambulacra. These extend from the peristome up to within a very short distance from the margin; and in some examples a faint continuation may be traced up to the extreme margin. In large examples the interradial plates have their transverse sutures very faintly channelled for some distance from the ambulacral furrow and the surface of the plates is faintly tumid—characters which, together with the small tuberculation above noticed, give a very ornate appearance to the actinal surface.

The peristome is small and subcircular, sometimes with a faint tendency to a decagonal form. The periproct is small and circular, situated rather less than its own diameter away from the margin.

Variations. In general structure this species appears to be more constant than usual in the genus; there is, however, considerable variation in the marginal contour, and this, at first sight, leads to the supposition that the form is more variable as a whole than it really is. In some examples the interradial incurvature of the margin is only slight, and the general outline is more oval than pentagonal, and these appear to be smaller examples; in others again the breadth is nearly equal to the length. The height and development of the dome varies greatly in different specimens even of the same size. Not unfrequently examples show some irregularity in the form of the outline; one of these has been figured in Plate LVIII, but the test otherwise is perfectly typical in character and is beautifully preserved.

Remarks. In many respects this species recalls *C. profundus* (d'Arch.), nobis; but is distinguished by the strongly incurved margins of the interradia, by the closed petals, which have also poriferous zones of different form, by the less abruptly rising dome, and by the subplane actinal surface, with the abruptly depressed subcentral concavity; the character of the tuberculation is also different. The present form is very nearly allied to *C. placunarius*, Agass. (*C. humile*, Klein, pars), the living representative of which occurs in the Indian Ocean. The fossil is, however, distinguished by the more prominent anterior radius, by broader petals which are less fully rounded at the extremity, by the greater width and tumidity of the interporiferous area, and by the more or less abrupt and conspicuous dome, as well as the widely-spaced ornamentation. The closed petals are very characteristic of *C. suffarcinatus*. It is distinguished from *C. latus*, Herklots, from the Tertiaries of Java (which Michelin has united to *C. placunarius*), by the more elongate and inflated petals, the narrower poriferous zone, and the apparently different margin of the test. Our form has also some alliances with the living *C. subdepressus* (Gray), Agass.; but the characters above noted will suffice to distinguish it. It is, however, unquestionably more nearly related to the living than to any of the fossil species.

Dimensions.

	millim.	millim.	millim.
Length of the test . . .	90	94	99
Breadth of the test . . .	77·5	82	91
Height of the test . . .	18	20	24

Locality. Khárak Island, Persian Gulf, near Bushire. Survey number G $\frac{262}{1}$.

Illustrations of the Species in Plate LVIII.

Fig. 1. Abactinal view of the test: natural size.
2. Actinal view of the test: natural size.
3. Profile view of the test: natural size.
4. Part of an ambulacral area and adjacent interradium: magnified.
5. Part of the margin of the peristome: magnified.

Subfamily LAGANINÆ.

The Laganidæ, as amended by Alex. Agassiz (Rev. Echini, p. 516), were characterized by him as follows:—"In this subfamily the connection between the two floors is made by walls running parallel to the edge of the test; well-developed buccal tubes; petals lanceolate; interambulacra extremely narrow on the actinal side of the test; ambulacral furrows straight, and outline more or less pentagonal."

Genus LAGANUM, *Klein*, 1734.

1. LAGANUM TUMIDUM, *Duncan & Sladen*. Plate LVIII, Figs. 6–10.

Marginal contour subpentagonal, with the angles well rounded, or sometimes with a tendency to an oval form. The length is greater than the breadth in the proportion of 1 : 0·957; and the greatest breadth is in a line with the termination of the anterolateral petals. The general form is depressed, but the edges are thick and swollen, forming a broad tumid border to the abactinal surface, between which and the slightly convex central region there is a distinct depression. The tumid border has the appearance of being bevelled towards the margin, and the summit of the test is only very slightly higher than the tumid border. The actinal surface is subplane, or very faintly concave, slightly and abruptly depressed round the peristome.

The apical system is subcentral and small, having its central area ornamented with small scrobiculated tubercles, and the madreporiform cleft sigmoid or flexuous in outline. The ocular pores are very small and frequently placed at the side of a small tubercular elevation. The ambulacral petals are long, and extend up to the flank of the tumid border; they are lanceolate in outline, the zones converging towards the outer extremity, which is almost closed, in fact in some examples may be described as completely so. At the apical extremity the petals appear wide and open. Sometimes the interporiferous area is faintly inflated, especially near the apical end. The odd anterior petal and the postero-lateral pair are subequal in length, and slightly longer than the antero-lateral pair, and the odd anterior is sometimes slightly narrower than the other petals, but not invariably so. The greatest width of the paired petals is rather nearer the apex than midway between the extremities, and is proportional to the length as 2 : 5, the actual dimensions of the postero-lateral petal in the type specimen being 15 millim. long, and its greatest breadth 6 millim. The poriferous zones are narrow at the apical extremity, but increase rapidly in width as they proceed outwards, and decrease again, but only slightly, along the outer third or fourth of the zone. Both the inner and the outer pores are small and subpyriform, and are united by a distinct but very narrow conjugating furrow; the intermediate costæ are low and comparatively broad, and are ornamented with 2–3 small scrobiculated tubercles and some minute miliary granules forming a serial line; sometimes the primary tubercles are aborted, and there is then a single line of miliaries. The broadest part of the poriferous zone is 1·6 millim., and is more than half the width of the interporiferous area at that place, which is rather nearer the outer end than midway between the extremities.

The widest part of the interporiferous area lies within the apical third of the petal and measures 3·5 millim., and the area contracts very slightly towards the apex.

The interradial areas are very narrow and band-like near the apex, and are extremely narrow on the actinal surface. The ornamentation consists of very small scrobiculated tubercles widely spaced, the intervening surface covered with very small uniform miliary granules comparatively widely spaced. The scrobicules of the interporiferous areas are more closely placed than in the interradial areas; and the primary tubercles on the actinal surface are slightly larger than on the abactinal surface, but decrease in size as they approach the median radial furrow.

The peristome is very small and subcircular, with a faint decagonal tendency, and the surrounding test is slightly but abruptly depressed towards its margin, forming a steeply inclined bevel. Along the median radial lines is a well-defined but rather shallow furrow, which extends from the peristome nearly to the margin, dying out gradually. At the extremity of each groove in the inclined peristomial margin is a pair of well-developed buccal pores; and behind these, along the median radial line of the furrow, there is frequently a uniserial line of granules extending for a considerable distance from the peristome; but they are not always present.

The periproct is small and circular, very nearly as large as the peristome, and the space between the outer edge of the aperture and the posterior margin of the test is exactly one third of the distance between the margin and the peristome.

In broken tests the internal columnar walls running parallel to the margin, which are characteristic of the genus *Laganum*, are well seen.

Variations and young Stages. The general characters of this species are on the whole remarkably constant, though naturally a certain amount of variation may be observed in a large series. This chiefly affects the marginal contour, and the amount and character of the marginal tumidity, and is probably in great part associated with the varying stages of growth—smaller examples being less strikingly pentagonal, and with a more or less definite tendency to a suboval contour; in these, again, the tumid border, though still definite, is less developed, and, instead of showing the bevel to the margin so characteristic of large specimens, is more tumidly rounded. In the smallest examples the convexity and height of the central region of the abactinal surface is proportionally slightly greater than in the adult forms, and sometimes also the concavity of the actinal surface is more noticeable. On the whole, however, the characters of the young form are so well defined, that there is no difficulty in recognizing the species in small examples 15 millim. in length.

Remarks. The form which appears to be the most nearly related to this species is the living *L. depressum*, from which, however, it is readily distinguished by its greater thickness, by the remarkably tumid border, by the greater prominence of the margin anteriorly, and by the well-rounded posterior radial angles.

Dimensions. Length of the test 47 millim., breadth 45 millim., height 10 millim.

Locality. Khárak Island. Survey-number G $\frac{302}{1}$.

Illustrations of the Species in Plate LVIII.

Fig. 6. Abactinal view of the test: natural size.
7. Actinal view of the test: natural size.
8. Apical system: magnified.
9. Ornamentation of the abactinal surface: magnified.
10. Portion of the test in the region of the peristome: magnified.

Family SCUTELLIDÆ.

Genus ECHINODISCUS, *Breynius* (*Leske* emend.).

We follow the description of this genus which is contained in the 'Revision' by A. Agassiz, p. 531.

There is a large, but unfortunately incomplete, form in the collection which differs very slightly from *Echinodiscus auritus*, Leske. The length is, however, slightly in excess of the breadth, and the postero-lateral expansion is only slight.

1. **Echinodiscus auritus**, *Leske*, var.

Locality. Khárak Island. Survey-number G $\frac{3\,1}{1}$.

Family SPATANGIDÆ.

Subfamily SPATANGINÆ.

Many fragments of Echinoidea belonging to this subfamily occur; but none are sufficient to enable us to give a generic or a specific name to them. The only form which may be named with doubt is a very interesting one, for it has the character of a young *Breynia*. It has six tubercles in a lateral interradium and the peculiar ambulacra of the genus; but no fascioles exist, and the greater part of the apical system is covered with a very adherent matrix.

Locality. Henjam Island. Survey-number G $\frac{3\,1}{5}$.

IV. *Remarks on the Species.*

The species of *Cidaris* from the Persian Gulf are very modern-looking, and one which has Goniocidaridean alliances is very probably the same as *Goniocidaris affinis*, nobis, from the Miocene of Kachh. There are some doubtful points about the species, however, and we have not thought it advisable to give the specimen a name. It appears to be an extinct form. The true *Cidaris* from the Makrán beds is allied to the Miocene species of Kachh and Kattywar, and somewhat to those of Gáj; but the species has its characteristics, and when a perfect specimen is found, doubtless the affinity will be shown to be with the Tertiary rather than with the recent species.

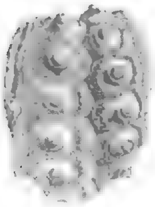
The numerous radioles indicate a number of *Goniocidaris*-like forms, and we regret the meagre nature of the collection of tests.

It is interesting to find parts of such a fragile urchin as a *Salmacis* in the collection, and the species is allied to *S. Dussumieri*, Agass. The small *Temnopleuri* are common, and the species is nearly allied to *Salmacis* in its affinities, although it is a true *Temnopleurus*. But it is an extinct form with small sutural grooves.

The species of *Clypeaster* described is very common at Khárak Island and characterizes the deposit. It is not a recent form, but is closely allied to *C. placunarius*, Agass., and to *C. subdepressus*, Gray. The closed condition of the petals is interesting. A *Laganum* is very common, and is distinguished from the living species *L. depressum* by a remarkable tumid border. The *Echinodisci* are fragmentary, and one must be associated with *E. auritus*. These forms, taken with the fragmentary and unsatisfactory Spatangoids, give a comparatively recent appearance to the fauna and its facies, which is certainly younger than that of the Miocene deposits of Western India.

PLATE LVI.

Figure 1. CIDARIS, sp. A part of a test, natural size (page 372).
2. Ambulacral plates, magnified.
3. Coronal plates of a species of CIDARIS, magnified (page 373).
4. Portions of a SALMACIS, magnified (page 374).
5. TEMNOPLEURUS SIMPLEX, Duncan and Sladen (page 375). The test, natural size.
6. Part of the test near the peristome, slightly magnified.
7. Ambulacral plate, magnified.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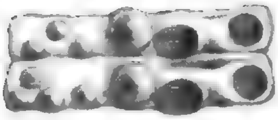
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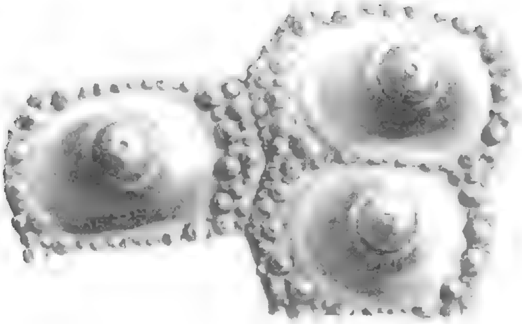
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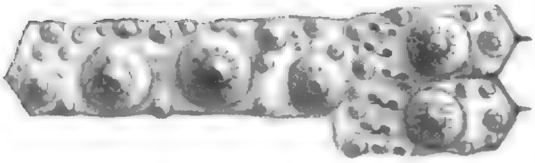
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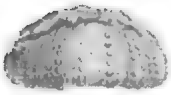
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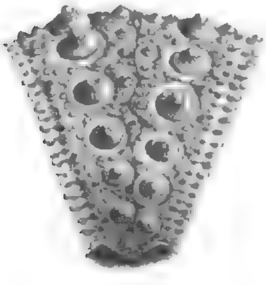
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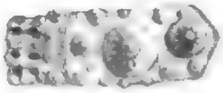
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Fossil Echinoidea from the Makrán Series.
(Miocene)

PLATE LVII.

SPINES OF CIDARIDÆ (pages 373, 374).

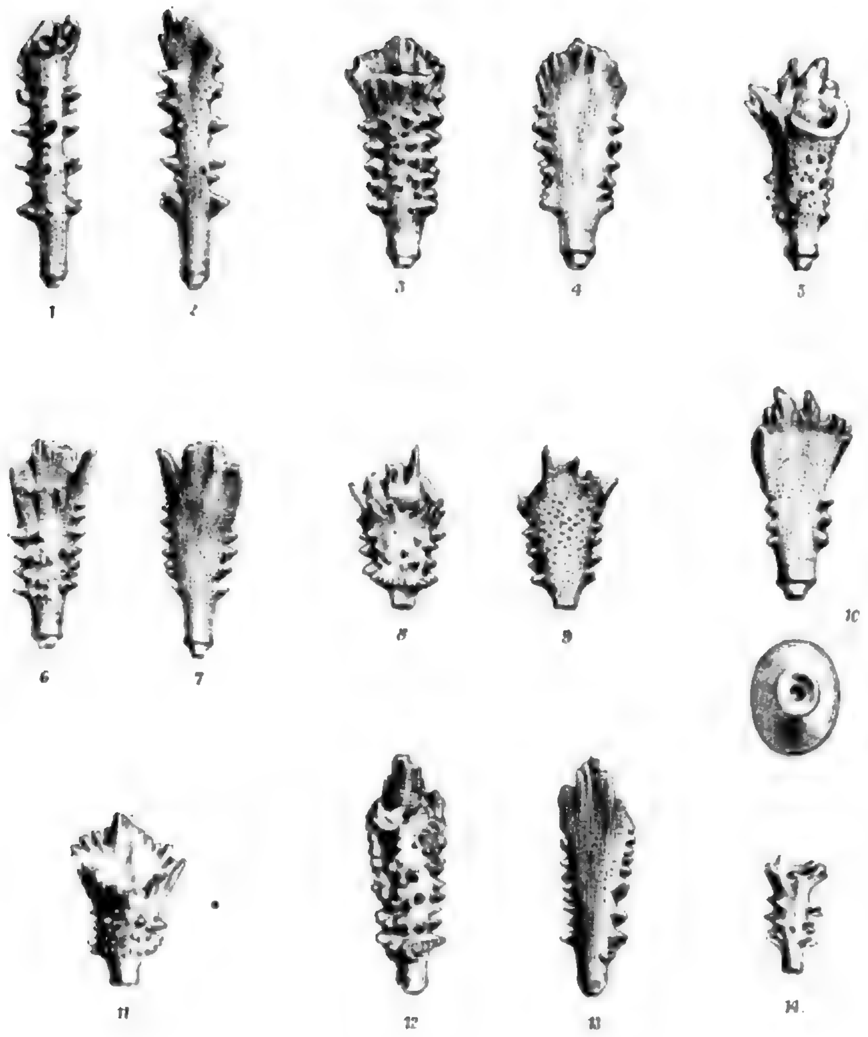
Figure 1. Front view of a tall spinulose radiole, with a shallow cup at the top surrounded by stout spinules, natural size.

2. Back view of the same, natural size.
3. Front view of a more stunted and flatter radiole, with close and short spinules, natural size.
4. Back view of the same.
5. Side view, showing the cup, natural size.

6, 8, 11, and 12. Front views of radioles of the same type, natural size.

7, 9, 13. Back views of the same, natural size.

10. Back view of a radiole and its base; the latter is magnified.
14. A small radiole, natural size.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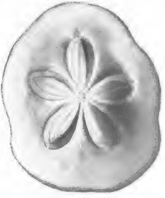
Duncan & Sladen del. A. S. Foord lith. Mintern Bros. imp.

Fossil Echinoidea from the Makrán Series.
(Pliocene.)

PLATE LVIII.

Figure 1. Clypeaster suffarcinatus, Duncan and Sladen. Abactinal view, natural size (page 376).
2. Actinal view, natural size.
3. Profile view, natural size.
4. Part of an ambulacrum and adjacent interradium, magnified.
5. Part of the margin of the peristome, magnified.
6. Laganum tumidum, Duncan and Sladen (page 379). Abactinal view, natural size.
7. Actinal view, natural size.
8. Apical system, magnified.
9. Ornamentation of the abactinal surface, magnified.
10. Part of the test near the peristome, magnified.



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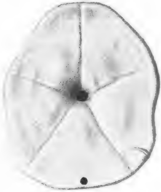

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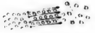

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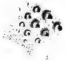

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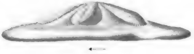

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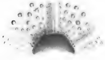

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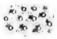

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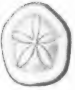

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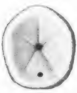

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Fossil Echinoidea from the Makrán Series.
(Pliocene.)

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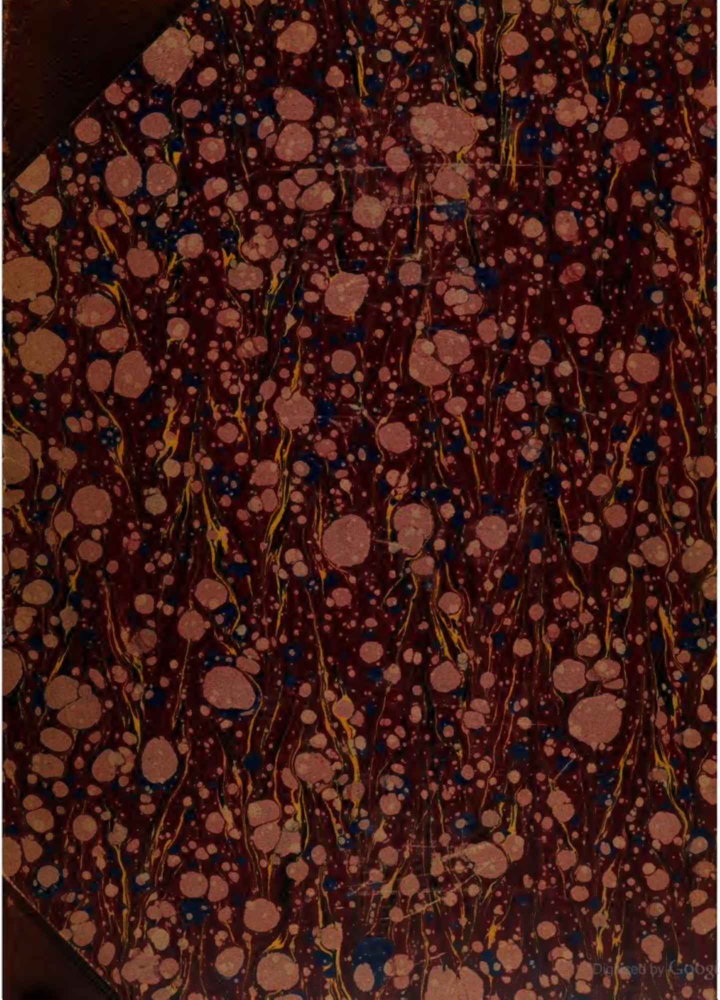210599.